FORD TRACTOR

shop manual

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TRACTOR AND IMPLEMENT DIVISION

Ford Motor Company

FORD TRACTOR SHOP MANUAL

for

TRACTOR SERIES

600-700-800-900

601-701-801-901-1801

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Prepared by

TRACTOR AND IMPLEMENT DIVISION

FORD MOTOR COMPANY

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FOREWORD

This manual contains complete service information on all Series 600 through 1801 Ford Tractors. The information contained herein will be useful to the inexperienced mechanics as well as the experienced ones.

Step-by-step procedures for removal, disassembly, inspection, repair, assembly, and installation are presented throughout the manual. Most of the major assemblies are shown disassembled, with each of the component parts arranged in the order of assembly. In many instances, a glance at the disassembled views will show you everything you need to know to assemble the parts.

Whenever possible, the special tools involved in the disassembly or assembly of the various units are illustrated.

Sections on Trouble Shooting, Specifications, and Special Tools are provided at the end of each chapter for quick reference.

The descriptions and specifications contained in this manual were in effect at the time the manual was approved for printing. The Tractor and Implement Division of Ford Motor Company reserves the right to discontinue at any time, or change specifications or design without notice or without incurring obligation.

TRACTOR AND IMPLEMENT DIVISION
FORD MOTOR COMPANY
SERVICE DEPARTMENT

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Part ONE

POWER PLANT

Chapter

I

Engine

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1. ENGINE REMOVAL AND INSTALLATION—SERIES 501 THROUGH 901

There are three different size engines used in Ford Tractors. The smallest engine of the three has a 134 cubic inch displacement and is available as a gasoline or LP-Gas model. The next larger size has a 144 cubic inch displacement and is available only as a diesel model. The largest of the three has a 172 cubic inch displacement and models are available for gasoline, LP-Gas or diesel operation.

All Ford Tractor engines are of the four cylinder, four cycle, overhead valve type.

When necessary to remove or install an engine, refer to the specific series tractor involved.

PREPARING THE TRACTOR

A. Series 501-701-901 Gasoline or LP-Engines

1. Disconnect the battery ground strap.
2. Drain the radiator, cylinder block, crankcase and the hydraulic system.
3. On tractors equipped with Select-O-Speed transmission, carefully drive the roll pin out of the P.T.O. control handle as shown in Figure 1. Remove the handle, nut and washer that attaches the control cable housing to the right rear side of the hood.

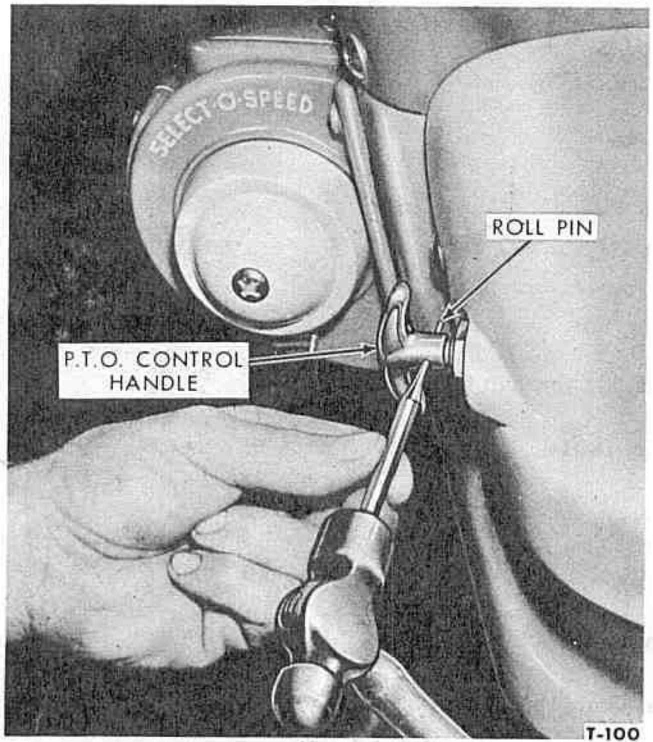


Figure 1—Removing P.T.O. Control Handle

4. Disconnect the bullet type connector adjacent to the headlamp switch on the right side of the hood rear lower panel, see Figure 2. Disconnect the fuel gauge wire from the fuel tank gauge.
5. Remove the bolts and screws that attach the hood to the rear lower panel and the instrument panel. Remove the grille from the front of the hood. Remove the two bolts from each hood side front lower panel flange.

501 Series Tractor: Loosen the three bolts that attach the steering shaft support to the transmission to provide clearance for removing the hood.

6. Loosen the clamps that secure the air cleaner tube to the carburetor and the air cleaner. Remove the air cleaner tube.
7. With an assistant, carefully lift the hood from the tractor.

   NOTE: ***On tractors equipped with a Select-O-Speed transmission, make certain that the P.T.O. control cable is clear of the hood.***

8. Remove the two air cleaner attaching screws and remove the air cleaner. Remove the bolt that attaches the fuel tank support to the left side of the battery support. On tractors equipped with power steering, disconnect the adjusting link from the pump. Remove the two bolts that attach the muffler outlet pipe front support to the fuel tank front support bracket.

Gasoline Engine: Turn the fuel tank shut-off valve clockwise as far as possible to close it. Disconnect the fuel line at the fuel filter, see Figure 3. Remove the bolts that attach the fuel tank support brackets to the cylinder block. Remove the one nut that attaches the fuel tank front support bracket to the cylinder block. With an assistant, carefully lift the fuel tank and brackets from the tractor.

LP-Gas Engine: Turn the fuel withdrawal valves to the closed position. Disconnect the flexible hose at the vaporizer inlet connection. Disconnect the water temperature gauge line and the oil pressure gauge line from the cable clip bracket at the right rear side of the fuel tank. Remove the four bolts that attach the fuel tank support brackets to the cylinder block. With an assistant, carefully lift the tank, heat shields and support brackets from the tractor.

B. Series 501-701-901 Diesel Engine

1. Disconnect the battery ground strap.
2. Drain the radiator, cylinder block, crankcase and the hydraulic system.
3. On a tractor equipped with Select-O-Speed transmission, carefully drive the roll pin out of the P.T.O. control handle as shown in Figure 1. Remove the handle, nut and washer that attaches the control cable housing to the right rear side of the hood.
4. Disconnect the bullet type connector adjacent to the headlamp switch on the right side of the hood rear lower panel, see Figure 2. Disconnect the fuel gauge wire from the fuel tank gauge.
5. Remove the bolts and screws that attach the hood to the rear lower panel and the instrument panel. Remove the grille from the front of the hood. Remove the bolts from each side of the hood lower panel flange. With an assistant, carefully lift the hood from the tractor.

   NOTE: ***On a tractor equipped with a Select-O-Speed transmission, make certain that the P.T.O. cable is clear of the hood.***

6. Loosen the clamp that connects the air cleaner tube to the air cleaner. Disconnect the clamp that attaches the air cleaner tube to the bracket on the left side of the hood rear lower panel and remove the tube. If the engine is equipped with a pre-cleaner, remove the vertical stack in place of the tube.

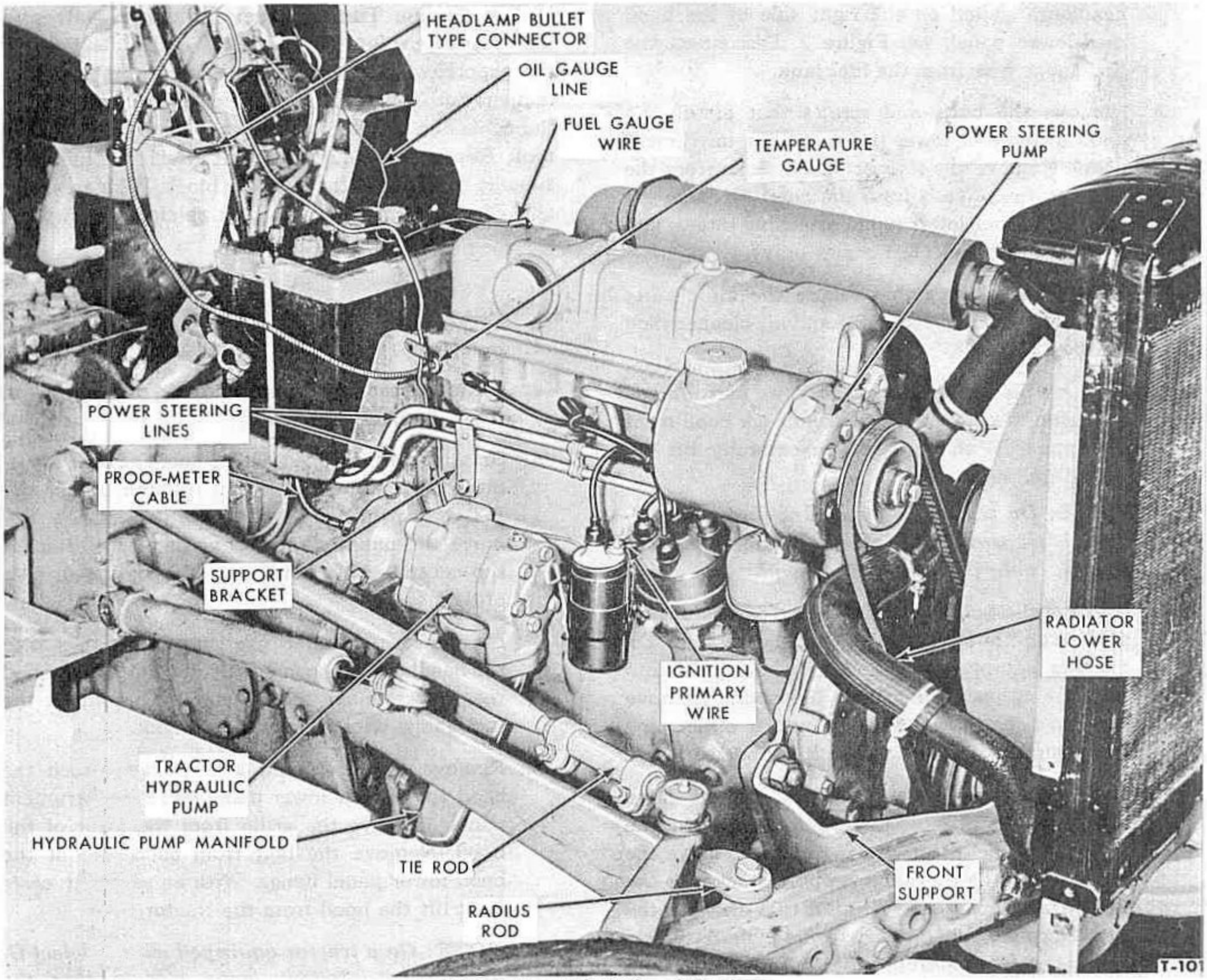


Figure 2—Right Side of Engine

7. On a tractor equipped with power steering, disconnect the adjusting link from the pump. Remove the two bolts that attach the muffler outlet pipe front support to the fuel tank front support bracket.

8. Turn the fuel tank shut-off valve clockwise as far as possible to close it. Disconnect the fuel line from the tank and from the fuel filter. Disconnect the excess fuel return line from the forward end of the fuel tank and from the "T" connection on the right side of the cylinder block.

9. Place a piece of wood across the top of the battery to prevent the fuel tank from accidentally contacting the battery posts. Remove nut and lock washer that attaches the fuel tank front support to the cylinder block. Remove the four fuel tank support attaching bolts. With an assistant, carefully lift the fuel tank and support brackets from the tractor.

10. Remove the battery from the battery tray.

C. Series 601-801 Gasoline Engine

1. Disconnect the battery ground strap.

2. Drain the radiator, cylinder block, crankcase and the hydraulic system.

3. On tractors equipped with a Select-O-Speed transmission, carefully drive the roll pin out of the P.T.O. control handle as shown in Figure 1. Remove the handle, nut and washer that attaches the control cable housing to the right rear side of the hood.

4. Disconnect the bullet connector adjacent to the

headlamp switch on the right side of the hood rear lower panel, see Figure 2. Disconnect the fuel gauge wire from the fuel tank.

5. Remove the bolts and screws that attach the hood to the rear lower panel and the instrument panel. Remove the four attaching bolts from the grille and remove it from the hood. Remove the two hood front lower panel attaching screws and remove the panel (801 series only).
6. Loosen the clamps that secure the air cleaner tube hoses to the carburetor and air cleaner then remove the tube.
7. Remove the grille attaching screws and remove the grille. Remove the bolt from each hood front side panel. With an assistant, carefully lift the hood from the tractor.

   NOTE: ***On tractors equipped with a Select-O-Speed transmission, make certain that the P.T.O. cable is clear of the hood.***
8. Remove the bolt that attaches the fuel tank support to the left side of the battery support. On tractors equipped with power steering, disconnect the adjusting link from the pump. Remove the two bolts that attach the muffler outlet pipe front support to the fuel tank support bracket.

Gasoline Engine: Turn the fuel tank shut-off valve clockwise as far as possible to close it. Disconnect the fuel line at the fuel filter, see Figure 3. Remove the bolts that attach the fuel tank support bracket to the cylinder block. Remove the one nut that attaches the fuel tank front support bracket to the cylinder block. With an assistant, carefully lift the fuel tank and support brackets from the tractor.

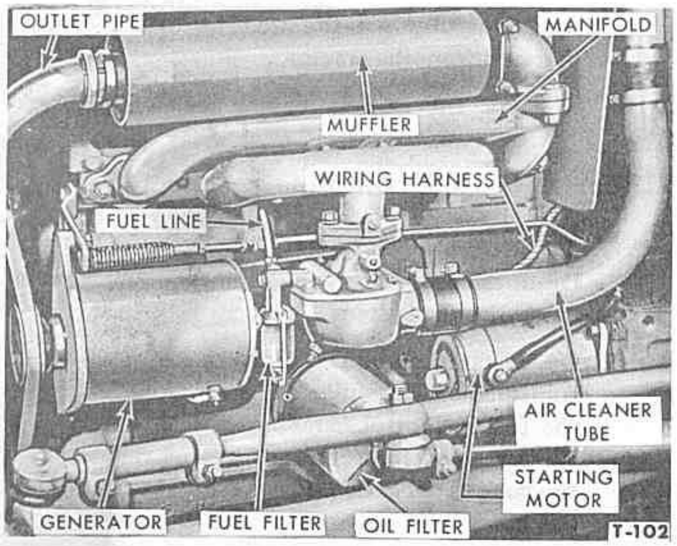


Figure 3—Left Side of Engine

LP-Gas Engine: Turn the fuel withdrawal valves to the closed position. Disconnect the flexible hose at the vaporizer inlet connection. Disconnect the water temperature gauge line and the oil pressure line from the cable clip bracket at the right rear side of the fuel tank. Remove the four bolts that attach the fuel tank support brackets to the cylinder block. With an assistant, carefully lift the tank, heat shields and support brackets from the tractor.

D. Series 601-801 Diesel

1. Disconnect the battery ground strap.
2. Drain the radiator, cylinder block, crankcase and the hydraulic system.
3. On a tractor equipped with Select-O-Speed transmission, carefully drive the roll pin out of the P.T.O. control handle as shown in Figure 1. Remove the handle, nut and washer that attaches the control cable housing to the right rear side of the hood.
4. Disconnect the bullet type connector adjacent to the headlamp switch on the right side of the hood rear lower panel, see Figure 2. Disconnect the fuel gauge wire from the fuel tank.
5. Remove the bolts and screws that attach the hood to the rear lower panel and the instrument panel. Remove the grille from the front of the hood. Remove the bolt from each side of the hood lower panel flange. With an assistant, carefully lift the hood from the tractor.

   NOTE: ***On a tractor equipped with a Select-O-Speed transmission, make certain that the P.T.O. cable is clear of the hood.***
6. Loosen the clamp that connects the air cleaner tube to the air cleaner. Disconnect the clamp that attaches the air cleaner tube to the bracket on the left side of the hood lower panel and remove the tube.
7. On a tractor equipped with power steering, disconnect the adjusting link from the pump. Remove the two bolts that attach the muffler outlet pipe front support to the fuel tank front support bracket.
8. Turn the fuel tank shut-off valve clockwise as far as possible to close it. Disconnect the fuel line from the tank and from the filter. Disconnect the excess fuel return line from the forward end of the fuel tank and from the "T" connection on the right side of the cylinder block.
9. Place a piece of wood across the top of the bat-

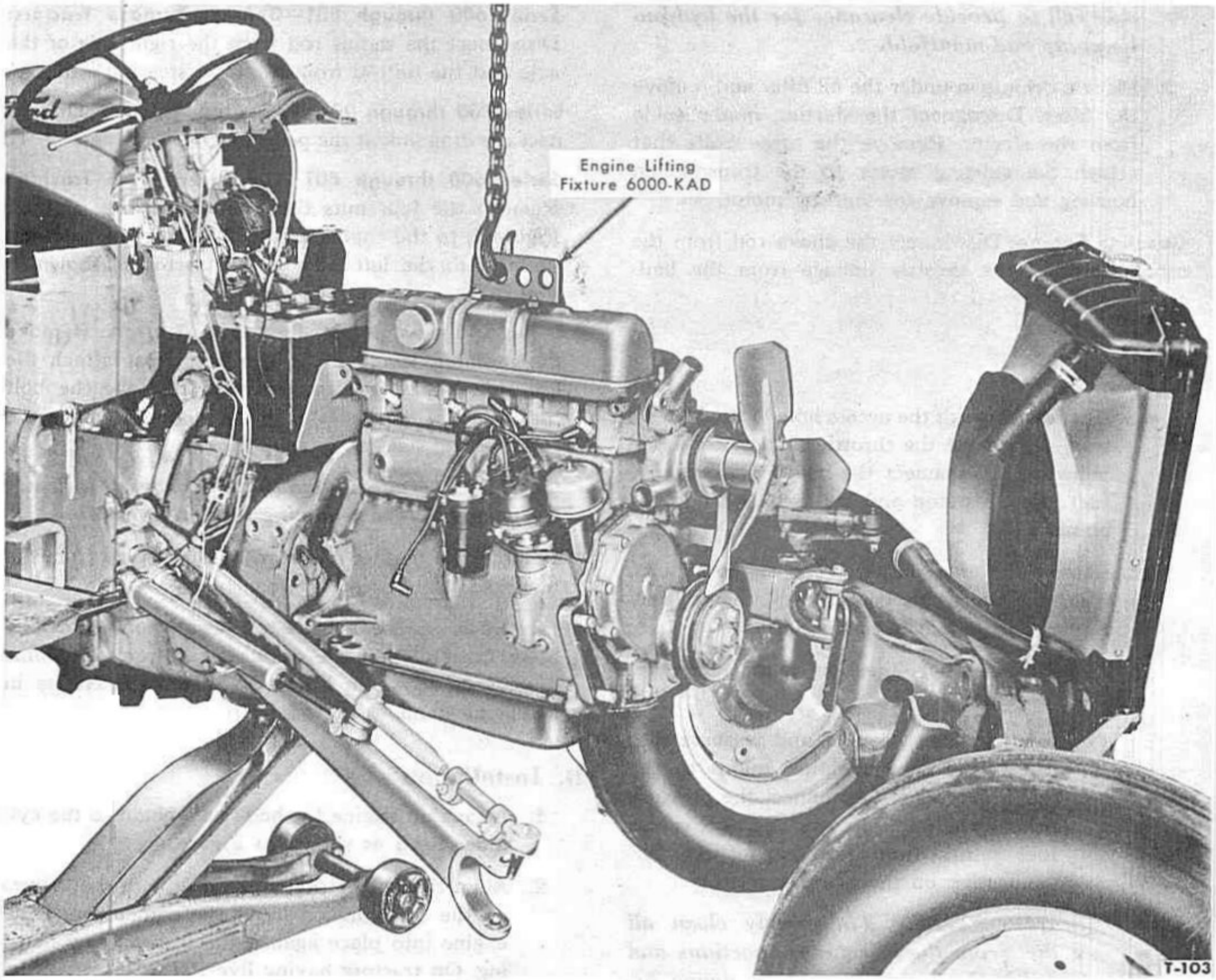


Figure 4—Removing Engine

tery to prevent the fuel tank from accidentally contacting the battery posts. Remove the nut and lock washer that attaches the fuel tank front support to the cylinder block. Remove the four fuel tank support attaching bolts. With an assistant, carefully lift the fuel tank and support brackets from the tractor.

10. Remove the battery from the battery tray.

ENGINE REMOVAL AND INSTALLATION

A. Engine Removal

Power Steering: Disconnect the two hydraulic lines that connect the pump to the steering gear as shown in Figure 2. Remove the bolt that attaches the power steering hydraulic lines support bracket to the valve cover. Disconnect the spark plug wires from the plugs. Remove the bolts, attaching the power steering pump mounting bracket to the cylinder block and water outlet connection. Remove the pump, mounting bracket and the two hydraulic lines as an assembly.

1. Disconnect the temperature gauge unit from the engine. Disconnect the radiator hoses from the engine. Disconnect the Proof-Meter cable from the hydraulic pump. Disconnect the primary wire from the ignition coil. Place a drain pan under the hydraulic pump and manifold assembly. Remove the five bolts that attach the pump and manifold to the engine and transmission and remove as an assembly. Disconnect the oil gauge line from the fitting in the cylinder block.

NOTE: **Row Crop Models:** ***Remove the right*** *side rail to provide clearance for the hydraulic pump and manifold.*

2. Place a drain pan under the oil filter and remove the filter. Disconnect the starting motor cable from the starter. Remove the three bolts that attach the starting motor to the transmission housing and remove the starting motor.

Gasoline Engine: Disconnect the choke rod from the carburetor and the throttle linkage from the bellcrank.

Diesel Engines:

a. Working through the access hole in the battery tray, disconnect the throttle linkage from the bellcrank. Disconnect the rod connecting the fuel injector pump and bellcrank at the bellcrank.

b. Loosen the two battery rear support bolts. Pivot the tray upwards and back, then tighten the bolts to hold it in this position.

c. Remove the fuel injection pump and fuel filter as follows:

(1) Remove the two nuts and washers that attach the fuel injection pump to the mounting flange. Disconnect the pressure lines from the injectors and the excess fuel return from the rear of the "T" connection on the cylinder head.

IMPORTANT: *Thoroughly clean all dirt from the injector connections and from the pump mounting flange before disconnecting.*

Cap the injector inlets and lines to prevent dirt from entering. Minute particles of dirt can cause malfunction of the injectors as well as seizure of the pump.

(2) Remove the two bolts that attach the fuel filter bracket to the cylinder head. Place a drain pan under the injection pump. Lift the injection pump with drive shaft, pressure lines and fuel filter from the engine as a unit.

IMPORTANT: *When removing the injection pump, make certain that the shaft remains in the pump to prevent fuel from leaking down into the crankcase.*

3. Install an engine lifting hook or chain to support the engine.

Series 600 through 801—General Purpose Tractors: Disconnect the radius rod from the right side of the axle and the tie rod from the right steering arm.

Series 700 through 901—Row Crop Tractors: Disconnect the drag link at the pedestal.

Series 600 through 801—General Purpose Tractors: Remove the four nuts that attach the axle support, Figure 2, to the engine. Carefully swing the axle and radiator to the left side of the tractor as shown in Figure 4.

Series 700 through 901—Row Crop Tractors: Remove the radiator. Remove the two bolts that attach the left side rail to the transmission. Remove the bolt that attaches the pedestal to the engine. Remove the pedestal and side rail as an assembly.

CAUTION: *Make certain that the pedestal is firmly supported before removing it from the engine.*

Remove the muffler and muffler outlet pipe from the manifold as an assembly.

4. Remove the engine-to-transmission attaching bolts. Carefully lift the engine away from the transmission as shown in Figure 4. Mount the engine in an engine stand.

B. Installation

1. Attach an engine lift hook or a chain to the cylinder head as shown in Figure 4.
2. Align the hub of the clutch disc with the splines on the transmission input shaft, then move the engine into place against the transmission housing. On tractors having live P.T.O. clutches, the P.T.O. shaft at the rear of the center housing should be turned slowly to engage the splines with the clutch discs.
3. Secure the engine to the transmission with two bolts at each side of the housing. Install the muffler and outlet pipe in place on the manifold, see Figure 3.

Series 600 through 801—General Purpose Tractors: Swing the axle support into place on the engine. Make certain that the radius rod is in place on the axle then install the four nuts that attach the front support to the engine, see Figure 2. Install the radius rod to axle attaching bolt. Connect the tie rod to the steering arm.

Series 700 through 901—Row Crop Tractors: Carefully move the pedestal and side rail assembly into position and install pedestal to engine mounting nut finger tight. Install the left side rail to transmission attaching bolts then tighten the pedestal to engine mounting nut. Install the radiator and connect the drag link to the steering spindle arm. Connect the radiator upper and lower hoses.

4. Install the remaining engine-to-transmission retaining bolts. Remove the engine lifting sling and the jack from under the transmission.
5. Connect the oil pressure gauge line to the fitting on the right side of the cylinder block. Using new "O" rings, install the hydraulic pump and manifold on the engine.

Series 700 through 901 (Row Crop) Tractors: Install the right side rail.

6. Connect the water temperature gauge line to the engine. Connect the Proof-Meter cable to the hydraulic pump, see Figure 2.

Diesel Engines: Loosen the battery rear support bolts and lower the tray into position, then tighten the bolts. Working through the opening in the battery tray, connect the throttle control rod between the injector pump and the bellcrank. Connect the rod from the throttle control lever arm to the bellcrank. Install the battery and connect the negative cable only.

7. Position the wiring harness, see Figure 3, in the attaching clips on the cylinder block and connect the three wires to the generator.

Gasoline Engine: Connect the choke control rod to the carburetor and the throttle rod to the bellcrank. Connect the primary wire to the ignition coil.

8. Position the starting motor on the engine rear cover plate and secure with three bolts.

   NOTE: ***Make sure the choke control rod bracket is in place when installing the starting motor inner attaching bolt (gasoline engine only).***

   Connect the starting motor cable to the starting motor.
9. Install a new oil filter or cartridge.
10. On a tractor equipped with power steering, hold the pump and lines in place on the engine and install the two pump mounting bolts. Connect the two hydraulic lines to the steering gear (600 through 801 Series). Connect the hydraulic line bracket to the valve cover with the attaching bolt, see Figure 2.
11. Install the fan belt and adjust the generator to permit ¼" deflection of the belt.
12. Position the power steering drive belt over the crankshaft pulley and over the power steering pump pulley.
13. Place a piece of wood across the top of the battery to prevent the fuel tank from accidentally contacting the battery posts. With an assistant, carefully lift the fuel tank and supports into place on the engine then install the nut and lock washer that secures the front support to the cylinder block. Install the four attaching bolts. Connect the fuel line to the fuel filter. Open the fuel shut-off valve.

    NOTE: ***If the engine is equipped with power steering, the right front fuel tank support bolt also connects to the power steering pump bracket.***

    If equipped with power steering, connect the power steering pump adjusting link to the pump. Adjust the turnbuckle to obtain ¼" belt deflection midway between the pulleys.

Diesel Engine:

a. Make certain that the fuel injection pump drive gear and the flywheel are properly positioned as detailed in Chapter V.

b. Position the fuel injection pump, fuel filter and pressure lines into place as an assembly. Install the two injection pump attaching nuts and washers. Install the fuel filter attaching bolts.

c. Carefully remove the caps from the injectors and pressure lines. Connect each pressure line to its respective injector. Connect the excess fuel line to the "T" connection in the cylinder head. Connect the other end of the excess fuel line to the fitting in the forward end of the fuel tank.

14. With an assistant, carefully lift the hood into postion on the tractor. Install all of the attaching nuts, bolts and screws. Install the grille. Connect the headlamp wiring.

Select-O-Speed Tractors: Connect the P.T.O. cable to the hood and install the P.T.O. control handle, see Figure 1.

15. Fill the hydraulic system to the proper level. Fill the crankcase to the proper level with the recommended oil. Fill the cooling system with water or the required anti-freeze.
16. Start the engine and check for oil and water leaks.

Gasoline and LP-Gas Engines: Adjust the ignition timing and carburetor as required.

2. ENGINE REMOVAL AND INSTALLATION—SERIES 1801

The removal procedure for the gasoline engine and diesel engine is very similar. Whenever a variation occurs, the procedure for both engines will be explained in the text.

A. Removal

1. Drain the coolant from the radiator, and cylinder block, the oil from the crankcase and the hydraulic oil from the center housing. Disconnect the battery ground cable, the positive (negative on diesel models) battery cable.

   NOTE: ***Do not drain the hydraulic oil from the reservoir.***

2. Disconnect the headlamp wire from the bullet type connector located at the rear of the right hood panel and from the connector located in the hydraulic reservoir area at the front of the hood.

3. Remove the six Phillips head screws, nuts, lock washers, flat washers and insulators from the front of the hood. Remove the Phillips head screws from the rear of the hood. Remove the bolts from the underside of the hood panels. Working through the hood opening, remove the nuts and lock washers that attach the hood to the top rear panel. With an assistant, carefully lift the hood from the tractor.

4. Remove the air cleaner tube. Remove the air cleaner attaching bolts and the air cleaner. On diesel engines, remove the air cleaner tube only. Remove the bolt that attaches the battery tray to the left side of the fuel tank rear support, see Figure 5.

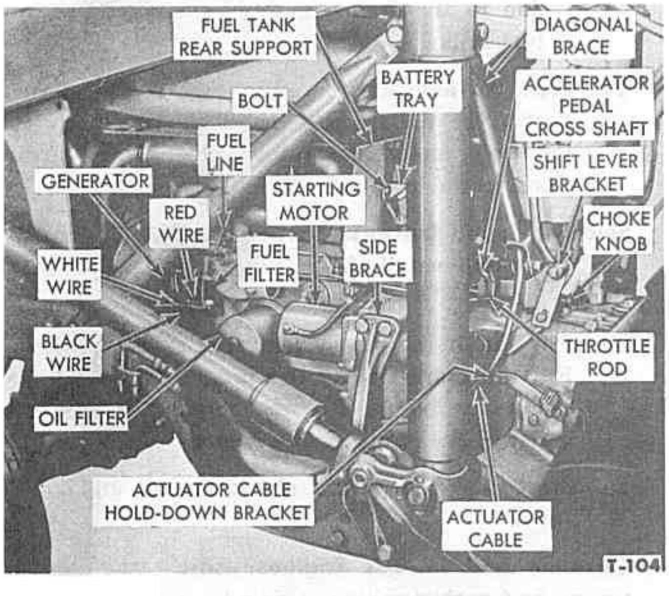


Figure 5—Left Side of Engine

5. Remove the cotter pin and clevis pin that attaches the adjusting link to the power steering pump. Remove the bolt that attaches the pump to the mounting bracket, Figure 6, then lay the pump to one side. Remove the nut and lock washer that attaches the power steering hose retaining bracket to the right front side of the cylinder block.

6. Place a piece of wood over the top of the battery to prevent the fuel tank from accidentally contacting the battery terminals. Loosen the bolt at the right side of the fuel tank support. Remove the bolt and oil pressure gauge retaining clip from the right side of the rear support. Turn the fuel shut-off valve clockwise to close it. Disconnect the fuel line from the filter. Disconnect the fuel gauge wire from the rear of the tank. Remove the two bolts that attach the muffler outlet pipe support bracket to the left side of the fuel tank front support (gasoline engine only). Remove the nut and lock washer that secures the fuel tank front support to the cylinder block. Disconnect the excess fuel line from the forward bottom side of the fuel tank (diesel engine only). Remove the bolt and lock washer from the left side of each fuel tank support. With an assistant carefully lift the fuel tank and supports from the tractor. Remove the wood from the top of the battery.

7. Place a pan under the oil filter, then remove the filter or cartridge. Disconnect the starting motor cable at the starting motor. Remove the three bolts and lock washers that attach the motor to the engine and remove the motor.

Gasoline Engines: Disconnect the throttle rod from the accelerator pedal cross shaft. Disconnect the governor compensating rod spring from the governor lever and remove the assembly. Disconnect the choke rod from the carburetor. Unscrew the knob from the rod. Remove the choke rod.

8. Disconnect the three wires from the generator, see Figure 5.

Gasoline Engines Only: Disconnect the primary wire from the ignition coil, see Figure 6. Lift the wiring harness from the three retaining clips and place it to one side.

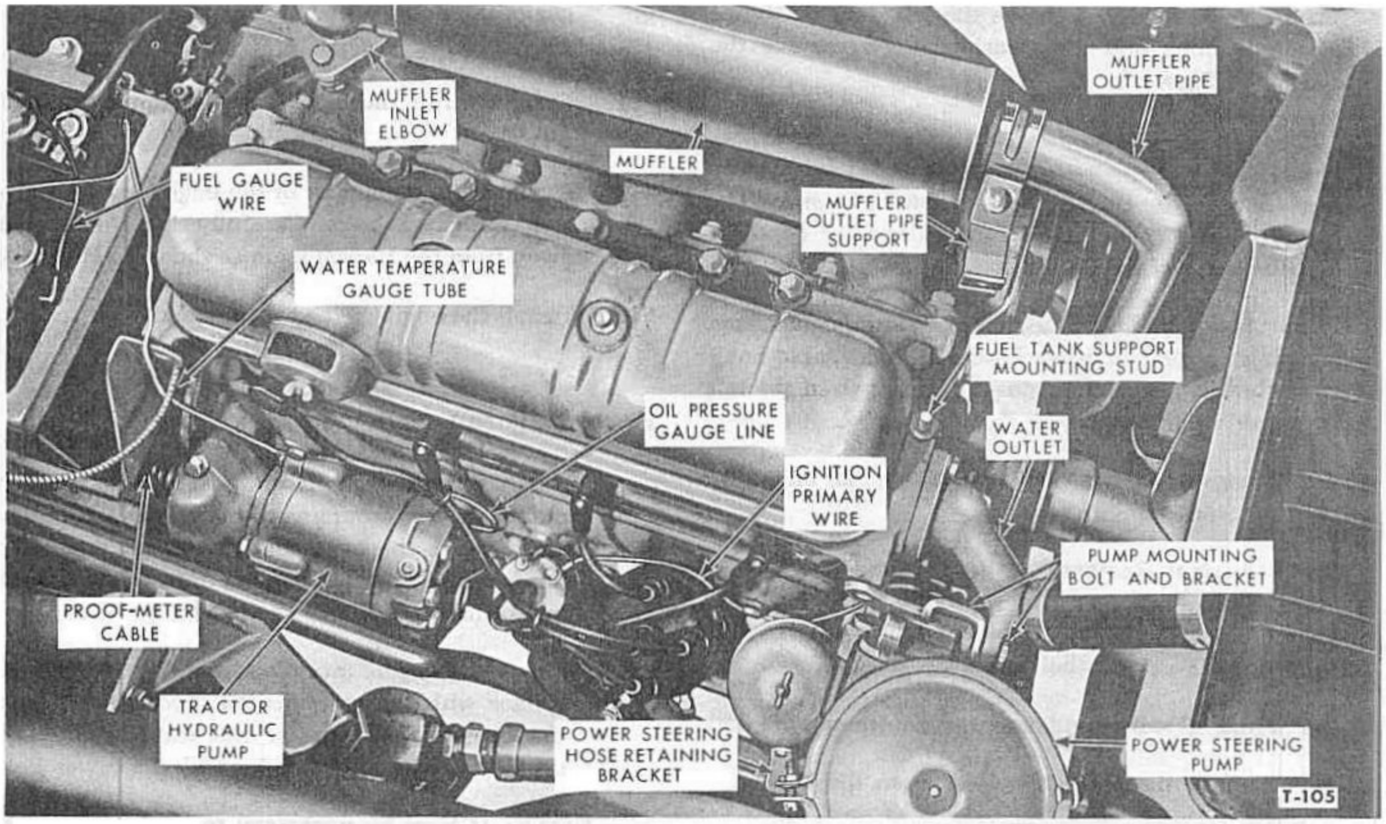


Figure 6—Top View of Engine

9. Disconnect the radiator hoses from the water outlet and from the water pump.

10. Disconnect the water temperature gauge tube from the right side of the cylinder block, see Figure 6.

11. Remove the five right side rail bracket attaching bolts and remove the bracket.

Tractor With Loader:

a. Remove the three bolts and lock washers that attach the control valve to the control valve support, see Figure 7. Remove the two bolts and lock washers that attach the control valve support to the cylinder block. Remove the "U" clamp that attaches the support to the filter tube mounting bracket and remove the support.

b. Remove the two bolts, nuts and lock washers that attach the right diagonal brace to the transmission and the loader frame. Manipulate the brace to free it from the transmission. It is not necessary to remove the brace from the control handles.

12. Place a drain pan below the hydraulic pump and manifold. Remove the five attaching bolts and washers from the pump and manifold. Carefully pry the hydraulic tubing away from the engine just enough to provide clearance for the hydraulic pump and manifold. Disconnect the oil pressure gauge line from the fitting in the cylinder block.

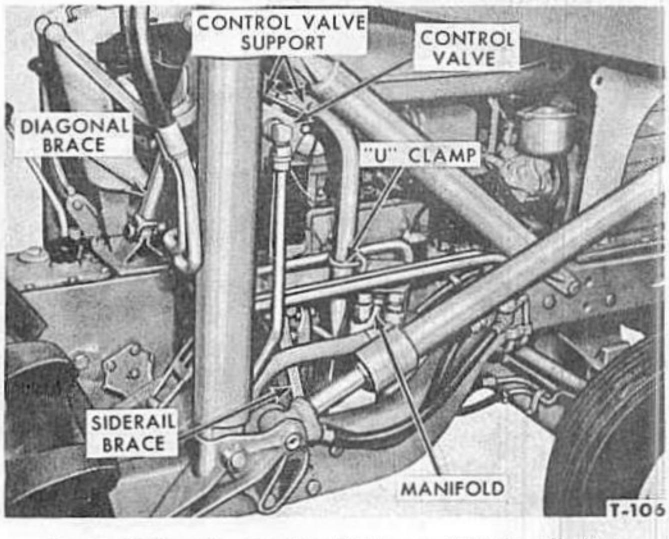


Figure 7—Loader Control Valve and Hydraulic Lines

Tractor With Loader: Remove the left diagonal brace attaching bolts and lock washers, then remove the brace, see Figure 5.

NOTE: ***If the tractor is equipped with a reversing transmission, remove the rear bolt and loosen the front bolt of the shift lever bracket. Then swing the bracket outward to provide clearance for removal of the diagonal brace inner bolt.***

Power Steering: Disconnect the actuator cable from the steering gear housing. Disconnect the cable hold-down bracket from the transmision and from the left frame side rail, see Figure 5.

13. Remove the two nuts that attach the engine to the front support.

Diesel Engine: Remove the battery and the battery support to gain access to the top two transmission-to-engine attaching bolts. Disconnect the fuel injection pump linkage at the bellcrank.

14. Place a jack stand under each frame side rail.
15. Remove the two step plates from the tractor.
16. Place a jack under the transmission housing to support the weight. Remove the four fender and side rail attaching bolts. Disconnect the tail lamp wire from the bullet type connector on the left axle housing. Remove the fenders.
17. Install an engine lifting fixture or chain on the engine. Connect a chain hoist to the engine lifting fixture.

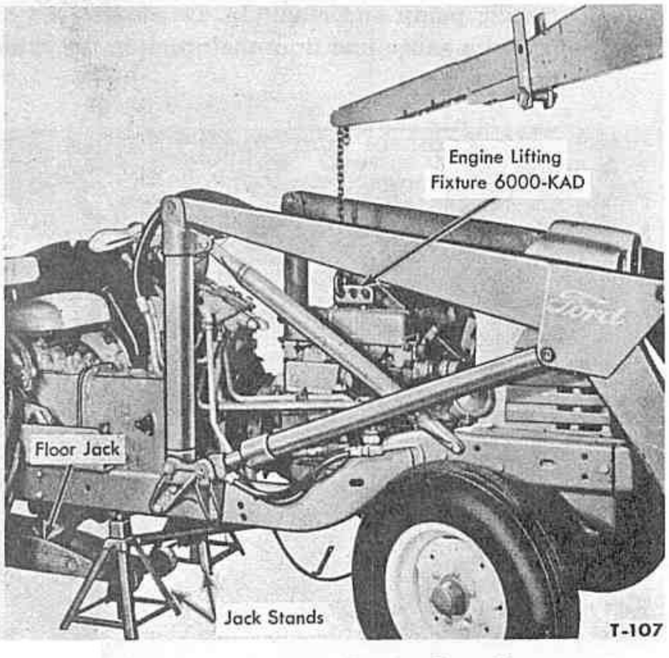


Figure 8—Removing Engine From Tractor

18. Carefully roll the axle rearward approximately 10″.
19. Remove the remainder of the engine-to-transmission attaching bolts. Carefully lift the engine away from the transmission as shown in Figure 8.
20. Install the engine in an engine stand.

B. Installation

1. Remove the four bolts and washers that attach the pump drive coupling to the crankshaft pulley and remove the front half of the coupling. Slip the front half of the coupling onto the hydraulic pump shaft.
2. Lower the engine into place and align the clutch splines with the transmission input shaft. Move the engine back against the transmission and install the two upper bolts and the lower bolt.

NOTE: ***It may be necessary to rock the engine slightly to enter the input shaft in the clutch.***

3. Carefully roll the rear axle forward while guiding the two engine support studs into the rubber mounts in the support. Install the two engine support nuts and flat washers.
4. Install the fenders. Install the frame side rail braces but do not tighten the attaching bolts. Install the rear fenders and tighten the attaching bolts. Tighten the side brace attaching bolts. Connect the tail lamp wire to the bullet type connector. Secure the wire to the brake cross shaft with the two retaining clips.
5. Align the hydraulic pump coupling hub with the crankshaft and install the four bolts and washers.
6. Install the two step plates.

Power Steering: Connect the power steering actuator hold-down bracket with the two upper left running board attaching bolts at this time.

Diesel Engine: Connect the fuel injection pump linkage to the bellcrank and install the battery tray and battery.

NOTE: ***Do not connect the positive battery cable at this time.***

Tractor With Loader: Install the left diagonal brace and secure with two bolts, lock washers and nuts.

Reversing Transmission: Secure the shift lever bracket to the transmission, see Figure 5.

7. Connect the oil pressure gauge line to the fitting in the left side of the cylinder block. Place two new "O" rings on the hydraulic pump manifold mating surface on the transmission and a new gasket on the cylinder block. Position the hydraulic pump and manifold in place and secure with five bolts and washers.

NOTE: ***It may be necessary to pry the hydraulic lines away from the engine to provide clearance for the pump and manifold.***

Tractor With Loader:

a. Secure the right diagonal brace with two bolts, lock washers and nuts.

b. Secure the control valve support to the lower end of the cylinder block with bolts, lock washers and nuts. Secure the control valve to the support with three bolts and lock washers. Connect the filter tube mounting bracket to the support with the "U" clamp.

8. Place the bushing over the temperature gauge heat bulb and connect the bulb to the cylinder block.

9. Connect the radiator lower hose to the water pump and the upper hose to the water outlet connection.

10. Connect the wiring harness to the generator.

Gasoline Engine: Connect the primary wire to the ignition coil. Place the wiring harness in the three retaining clips on the cylinder block.

11. Working from the front side of the reversing transmission shift lever bracket, insert the threaded end of the choke rod through the bracket and install the knob.

Gasoline Engine: Connect the choke rod to the carburetor.

12. Place a piece of wood over the top of the battery to prevent the fuel tank from accidentally contacting the battery terminals. With an assistant, carefully position the fuel tank and supports in place on the engine. Install and tighten the nut and lock washer that attaches the fuel tank front support to the cylinder block. Install and tighten the four fuel tank support mounting bolts, nuts and lock washers. Make certain that the oil pressure gauge tube retaining clip is in place on the right rear bolt. Connect the fuel line to the filter.

Diesel Engine: Connect the excess fuel line to the bottom forward end of the tank.

Turn the fuel shut-off valve counterclockwise to open the valve. Remove the wood from the battery.

13. Attach the muffler outlet pipe support to the fuel tank support with two bolts and lock washers. Attach the battery support to the fuel tank support with a bolt, lock washer and nut, see Figure 5.

Power Steering: Connect the power steering pump to the mounting bracket with a bolt and lock washer. Connect the belt to the pump and connect the adjusting link with a clevis pin and cotter pin. Adjust the link to obtain 1/4" deflection of the belt midway between the pulleys. Attach the power steering hose retaining bracket to the right front side of the cylinder block with a nut and lock washer.

14. Install the air cleaner and air cleaner tube.

NOTE: ***If the tractor is equipped with a diesel engine, the air cleaner should be in place making it necessary only to install the tube or the pre-cleaner stack.***

15. Position each hood panel in place on the tractor and install the attaching insulators, bolts, flat washers, lock washers, nuts and screws. Connect the headlamps to the bullet type connector at the front of the hood and at the connector located near the right rear side of the hood.

16. Connect the cable to the battery. Fill the radiator with coolant. Fill the crankcase to the proper level with the recommended oil. Fill the hydraulic system to the proper level with the recommended oil.

17. Start the engine and check for leaks.

Gasoline Engine: Adjust the ignition timing, and carburetor as required.

3. CYLINDER HEAD AND VALVES

The cylinder head assembly consists of the rocker arm mechanism, valves, springs, and valve guides.

The procedures below cover the removal, disassembly, cleaning, inspection, repair and assembly of the cylinder head and valves.

A. Cylinder Head Removal

1. Remove the hood. Drain the coolant from the radiator and cylinder block.
2. Remove the fuel tank and fuel tank support brackets.
3. Disconnect the muffler from the exhaust manifold.

Gasoline Engine: Disconnect the choke rod and accelerator rod from the carburetor.

Gasoline or L P–Gas Engine: Disconnect the fuel line from the fuel filter or carburetor. Disconnect the spark plug wires at the plugs.

CAUTION: ***Refer to Chapter VI, Section 6 before attempting the removal of an LP-Gas fuel tank.***

Diesel Engine: Remove the air cleaner tube. Disconnect the manifold heater wires at the manifold heaters.

4. Remove the nuts and washers that attach the intake and exhaust manifold to the cylinder block. Remove the manifold.

   NOTE: ***On diesel engines, the intake manifold is separate from the exhaust manifold.***

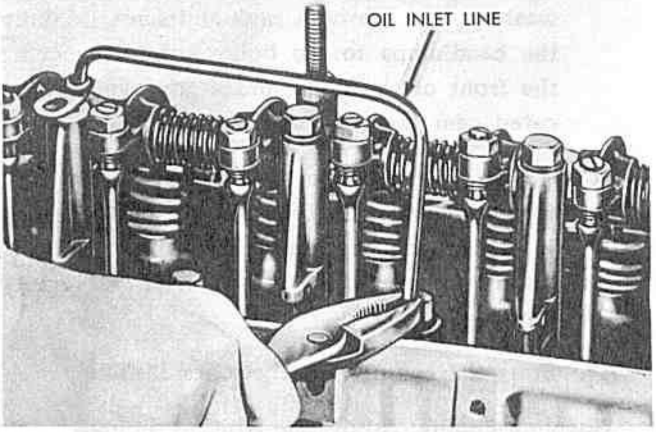


Figure 9—Removing Rocker Arm Oil Inlet Line

5. Disconnect the water temperature gauge from the cylinder head. Remove the radiator upper hose.
6. Disconnect the adjusting link from the power steering pump. Remove the bolts that attach the pump to the cylinder head and the water outlet elbow.
7. Remove the rocker arm cover and gasket.
8. Loosen the rocker arm support attaching bolts evenly and alternately until all tension has been relieved then remove the bolts and washers.
9. Remove the rocker arm oil inlet line from the cylinder block as shown in Figure 9. Lift the oil inlet and outlet lines from the rocker arm supports. Lift the rocker arm assembly from the cylinder head. Lift the push rods out of the cylinder head, and place in a numbered rack so that they may be reinstalled in their respective position.

Diesel Engines:

a. Disconnect the excess fuel line at the tee connection, Figure 10. Remove the four bolts that attach the excess fuel line to the injectors and remove the line.

b. Remove all dirt from the fuel injector pressure line connections. Disconnect the pressure line at each injector. Cap off the exposed ends of the injectors and the lines to prevent the entry of dirt.

c. Remove the two attaching bolts from each injector. Attach Injector Lifting Bar, EIADDN-17098 to the injectors as shown in Figure 11. Make sure the legs of the tool bear against the cylinder head rather than the rubber injector seal. Remove the fuel injectors and the injector seat washers from the cylinder head.

d. Remove the two bolts and lockwashers that attach the fuel filter to the cylinder head.

10. Remove the bolts that attach the cylinder head to cylinder block. Carefully lift the cylinder head from the block.

NOTE: ***If available, use Cylinder Head Overhaul Fixtures, 6085-F.***

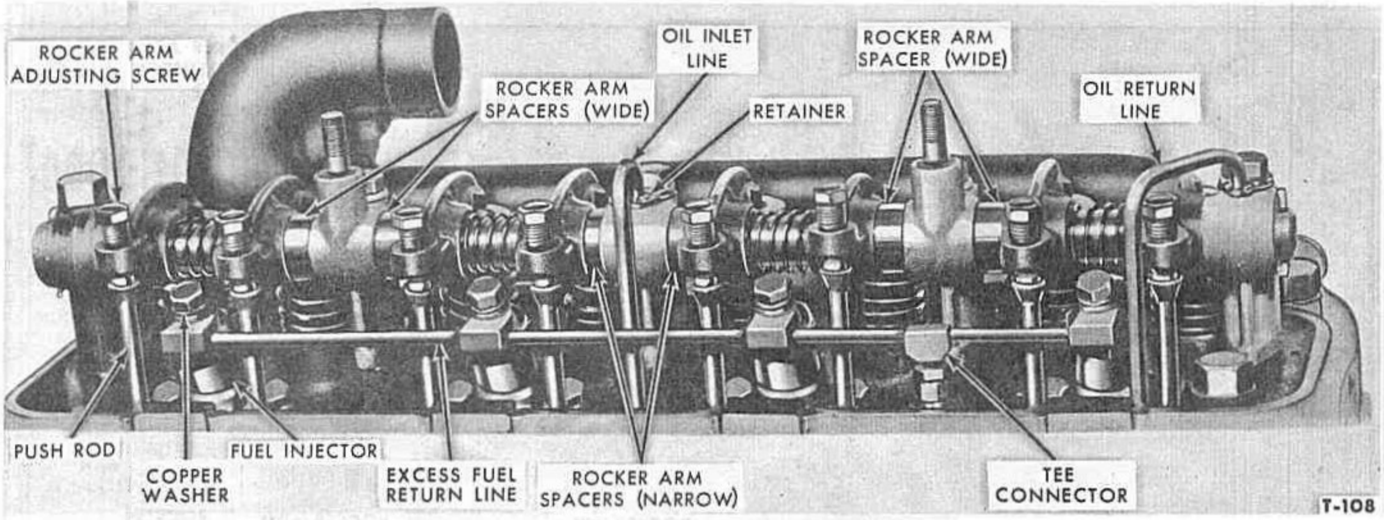


Figure 10—Diesel Engine With Rocker Arm Cover Removed

B. Cylinder Head Disassembly

1. Remove the two bolts and lockwashers that attach the water outlet elbow to the cylinder head. Remove the elbow and thermostat.

2. Prior to removing the valves, clean all carbon deposits from the combustion chambers. Position Valve Spring Compressor 6513-EE over the valve and spring as shown in Figure 12 and compress the valve spring. Remove the two valve spring retainer locks, sleeve, retainer, spring and spacer from each valve. Lift the valves from the head and place them in a numbered rack so that they can be installed in their respective guides.

   NOTE: ***Exhaust valves are provided with a cap and do not have a sleeve. Spacers are used originally only under the exhaust valve springs on diesel engines.***

3. Remove the cotter pin, flat washers and spring washer from each end of the rocker shaft, Figure 13.

   NOTE: ***Diesel engines do not have the flat washers and spring washer.***

   Remove the rocker arms and rocker arm locat-

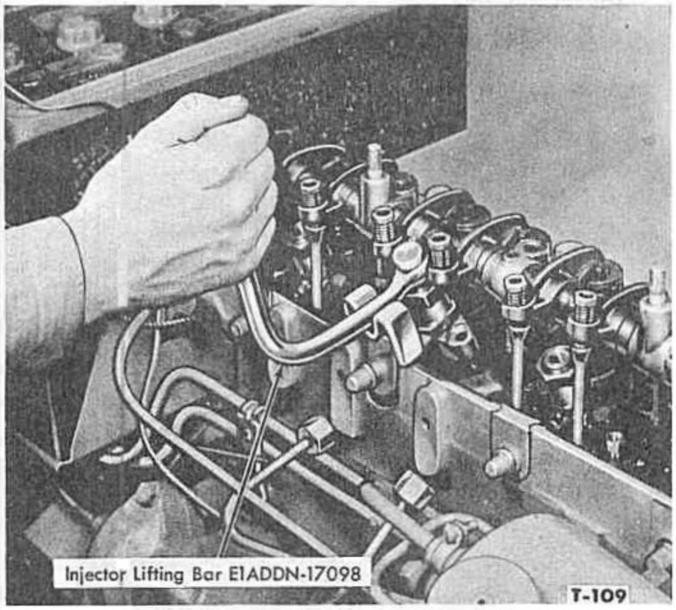


Figure 11—Removing Fuel Injectors

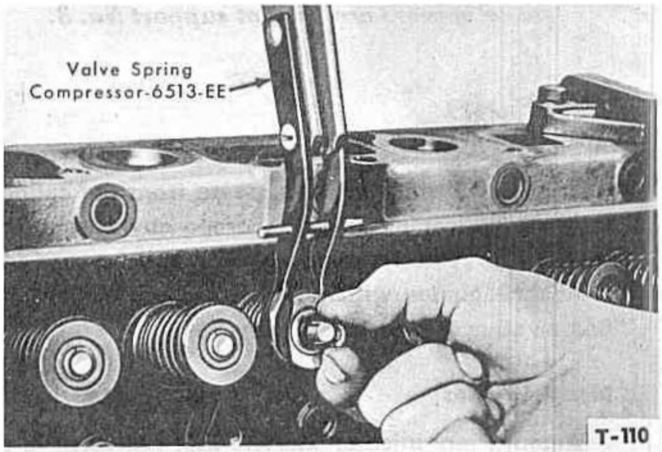


Figure 12—Removing Valve Spring Retainer Locks

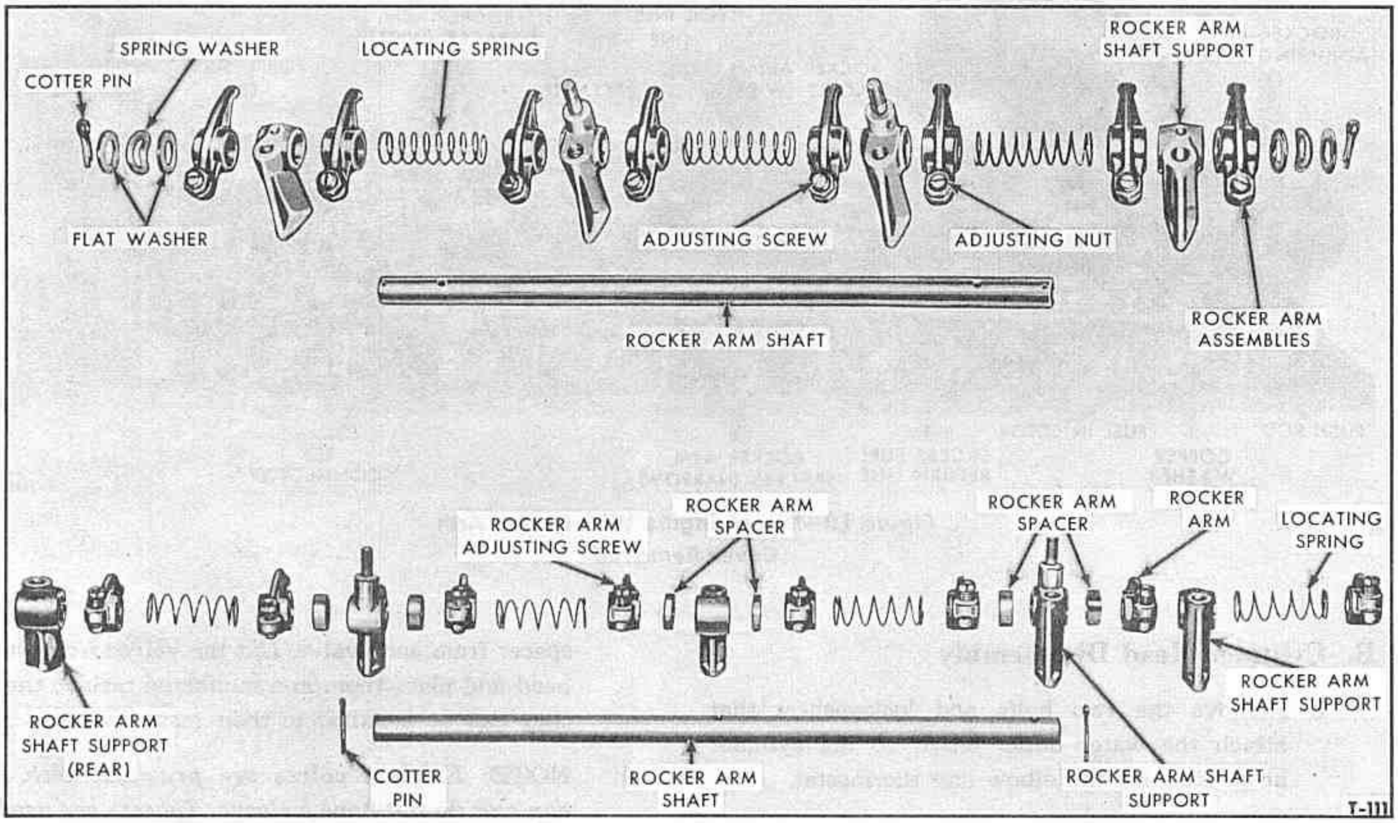


Figure 13—Rocker Shaft Assemblies

ing springs from the shaft. Drill a hole through a plug in the end of the rocker arm shaft. Insert a rod through the hole that is long enough to contact the opposite plug then drive the plug out of the shaft. Drive the remaining plug out of the shaft.

NOTE: ***Diesel engines are provided with a rocker arm spacer on each side of No. 2, 3 and 4 rocker shaft supports, Figure 13. The narrower spacers are used at support No. 3.***

C. Cleaning

Gasoline Engines:

Remove all grit, dirt and grease from the cylinder head with cleaning solvent. Scrape any carbon that was not previously removed with a scraper. Clean the valve guides with a valve guide cleaning tool. Scrape all gasket surfaces clean.

Diesel Engines:

Remove any injector washers that remained in the bores with a screwdriver that has approximately the same width blade at the I. D. of the washer. Tap the screwdriver so that the blade bites into the washer, then twist the screwdriver to free the washer. Clean all carbon and dirt from the injector bores.

Diesel Engines:

Soak the head gasket surface with paint remover to

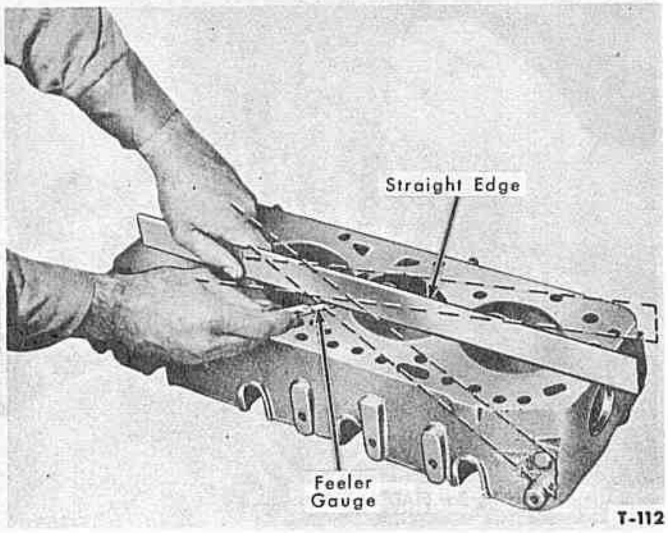


Figure 14—Checking Cylinder Head Flatness

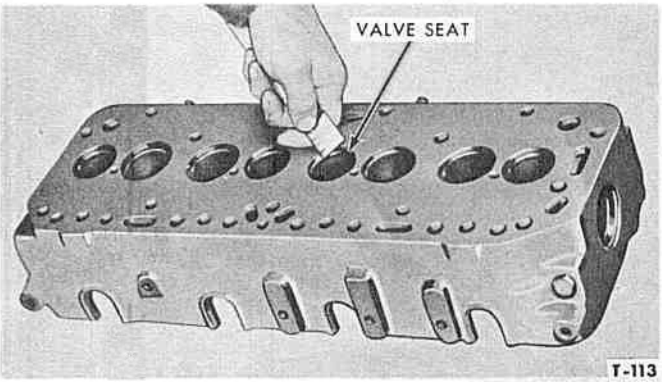


Figure 15—Measuring Valve Seat Width

loosen the gasket material. Carefully scrape the gasket from the head, applying the paint remover as required.

CAUTION: ***Do not allow paint remover to contact the body or clothing.***

Clean all carbon and dirt from the valves with a mechanical wire brush. Clean all sludge and dirt from inside the rocker shaft. Discard all old gaskets and seals.

D. Inspection

1. Inspect the cylinder head for being cracked, nicked or burred on the gasket surfaces. Replace the head if it is cracked. Remove all burrs or nicks with an oil stone. With a straight edge and thickness gauge, check the flatness of the cylinder head as shown in Figure 14. Specifications for flatness are 0.005 inch maximum overall or 0.003 inch in any 5 inches. Check the exhaust valve seat inserts for cracks, looseness or excessive wear. Replace the inserts if any of these conditions exist. Check the width and concentricity of the valve seat, Figures 15 and 16. Replace the seats if they are pitted, if they are wider than 0.110 inch, or if the runout exceeds 0.0015." Measure the inside diameter of the valve guides with a telescope gauge as shown in figure 17. If the diameter of the guides exceeds 0.345", replace them. Check the core hole plugs in the cylinder head for leakage. Replace plugs that show evidence of leakage.

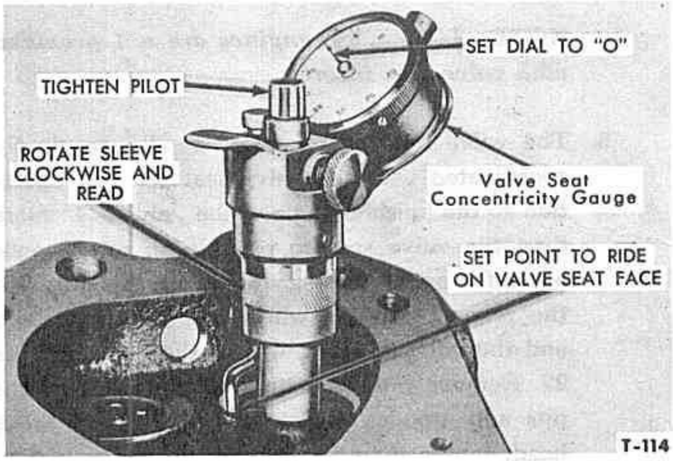

SET DIAL TO "O"
TIGHTEN PILOT
ROTATE SLEEVE CLOCKWISE AND READ
Valve Seat Concentricity Gauge
SET POINT TO RIDE ON VALVE SEAT FACE
T-114

Figure 16—Checking Valve Seat Concentricity

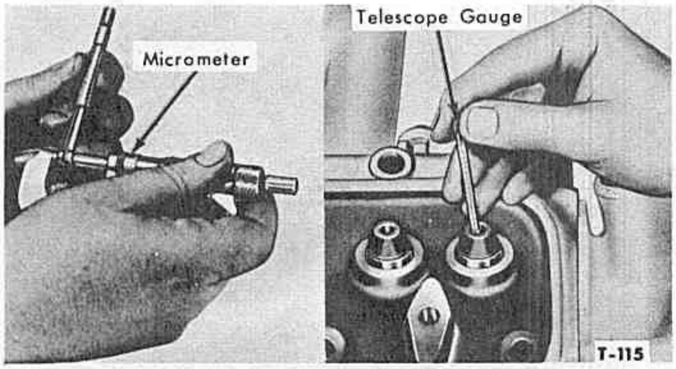


Figure 17—Measuring Inside Diameter of Valve Guides

2. Discard burned, cracked or warped valves that show any evidence of heat checks on the face of the valve, or that have a head margin of less than $\frac{1}{32}$" after being refaced, Figure 18. Reface all valves.

3. Discard valve springs that show evidence of rust. Check each valve spring for squareness as shown in Figure 19. Discard valve springs that are in excess of $\frac{1}{16}$" of being square. Check the spring tension as shown in Figure 20. Each spring should exert a pressure of 54-62 lbs. when compressed to a length of 1.82" or 124-140 lbs.

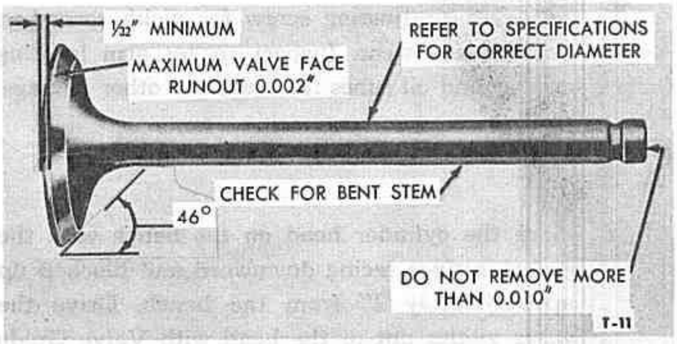

1/32" MINIMUM
REFER TO SPECIFICATIONS FOR CORRECT DIAMETER
MAXIMUM VALVE FACE RUNOUT 0.002"
CHECK FOR BENT STEM
46°
DO NOT REMOVE MORE THAN 0.010"
T-11

Figure 18—Critical Valve Tolerances

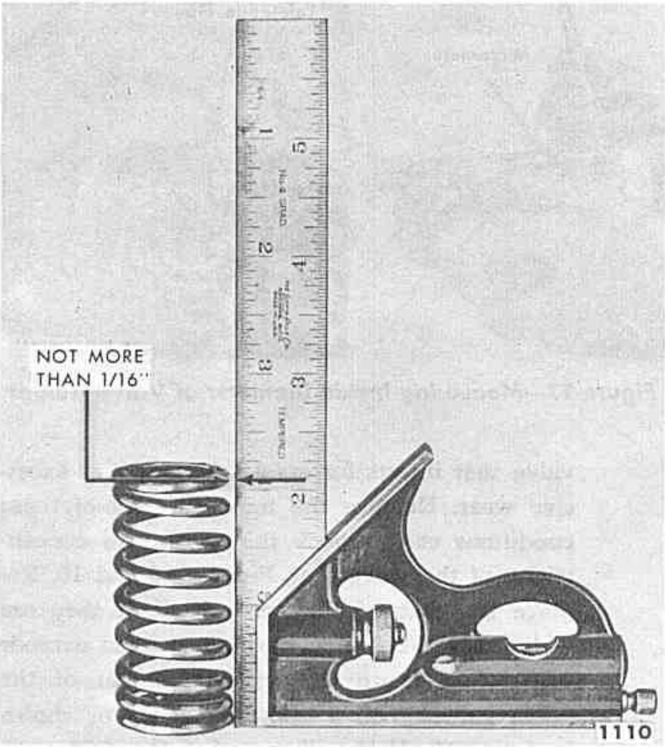


Figure 19—Checking Valve Spring Squareness

when compressed to 1.505". If the spring pressure is 7 or more lbs.. below specifications, replace the spring.

NOTE: ***Never immerse valve springs in a caustic cleaning solution as it may remove the protective coating and cause them to rust.***

4. Check the rocker arm to shaft clearance with a micrometer and a telescope gauge. If the clearance exceeds 0.007", replace the defective parts. Inspect the pad end of the rocker arm for roughness or grooves. Replace the rocker arms if these conditions exist. Inspect the rocker arm adjusting screws and the push rod end of the rocker arms for stripped or worn threads, and the ball end of the adjusting screw for nicks, scratches, or excessive wear. Inspect rocker arm locating springs and oil tubes for breaks or other damage.

E. Repair

1. Place the cylinder head on the bench with the gasket surface facing downward and blocked up approximately 2" from the bench. Drive the valve guides out of the head with Valve Guide Remover 6510-AF as shown in Figure 21. Place the new valve guide in position and slip the Adapter of 6510-AF over the guide. Drive the guide into the cylinder head until the Driver bottoms on the Adapter.

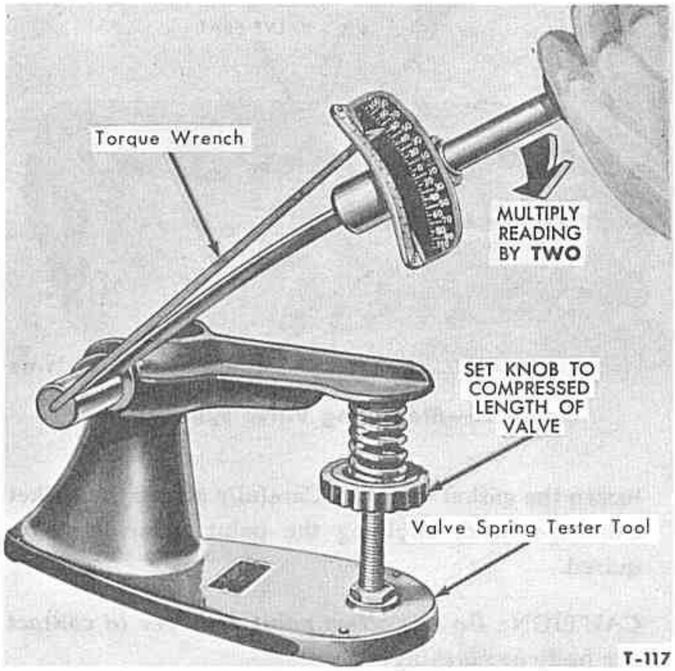


Figure 20—Checking Valve Spring Tension

2. Carefully remove the defective exhaust valve seat inserts with a tool that will not damage the insert bore. Clean the valve insert bore thoroughly. Place the new valve seat inserts on dry ice and allow them to chill for approximately 20 minutes, then drive them into place with Step Plate 630-5 from Tool Set FT-48. Reface the valve seat insert as detailed in sub-paragraph 4 below.

   NOTE: ***144 cu. in. engines are not provided with valve seat inserts.***

3. The valve refacing operation should be closely coordinated with the valve seat refacing operation so the finished angle of the valve is 1° more than the valve seat to provide an interference angle for better seating, Figure 22. Be sure that the refacer grinding wheel is properly dressed and the valve is set at 46° to the wheel, Figure 22. Remove only enough stock to clean up the pits and grooves. Check the edge of the valve head; if less than 1/32 margin as shown in Figure 18, replace the valve. Grind off all groove or

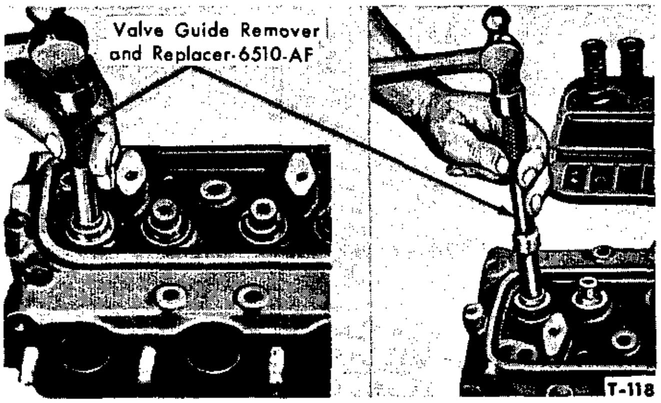


Figure 21—Replacing Valve Guides

score marks from the end of the valve stem, then chamfer the sharp edge slightly.

NOTE: *Do not remove more than 0.010" from the end of the valve stem.*

Position the valve spring retainer and valve retainer locks on the exhaust valve stem as shown in Figure 23. Exert pressure against the valve spring retainer to seat the locks against the valve stem. Install the rotating cap on the end of the valve stem and press firmly on the cap while exerting pressure on the spring retainer. If no movement is felt at the retainer, the cap is seating at the valve. Remove enough stock from the end of the valve stem to obtain a clearance of 0.002-0.004 inch between the cap and stem, Figure 23. Keep each rotating cap with its respective valve after the correct clearance has been established.

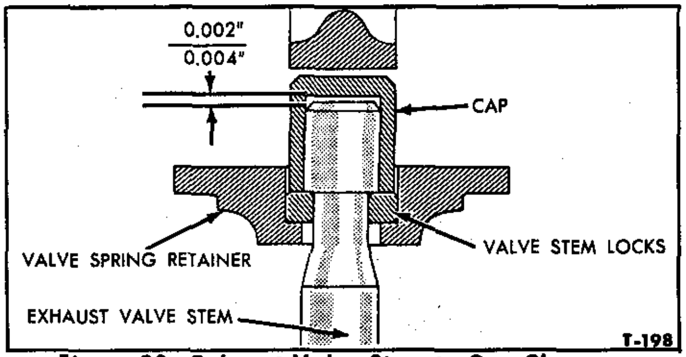


Figure 23—Exhaust Valve Stem to Cap Clearance

4. Insert the seat refacing pilot into the valve guide and expand the pilot until it fits tightly. Make certain that the stone is dressed to a 45° angle and is of the correct grit.

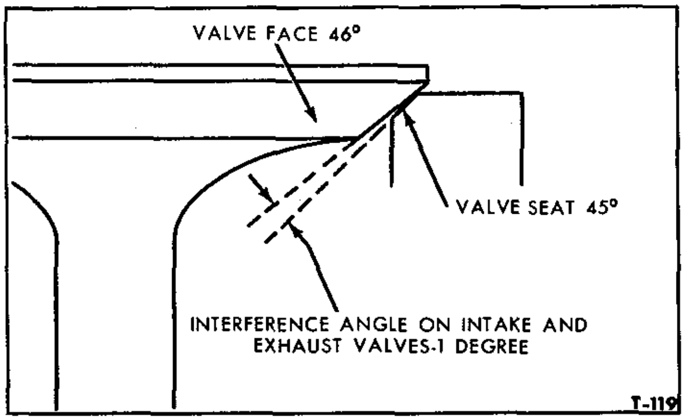


Figure 22—Interference Angle on Valve Face

NOTE: ***The stone must be dressed frequently to assure correct grinding of all valve seats.***

Grind the seat, as shown in Figure 24, only enough to remove all pits and grooves or to eliminate an out of round condition. After refacing, if the seat exceeds the width shown in Figure 25, it must be narrowed. Remove enough stock from the top of the seat (lower the seat) with a 60° stone and enough from the bottom with a 30° stone (raise the seat) to make the width within specifications, Figure 25. Check the valve seat concentricity after the refacing operation.

The finished valve seat should contact the approximate center of the valve face circumference. To determine where the valve seat contacts the face, coat the seat with prussian blue, then set the valve in place. If the blue is transferred to the center of the valve face, the seat contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

F. Cylinder Head Assembly

1. Lubricate all moving parts with engine oil prior to assembly.
2. Apply sealer to two new rocker shaft plugs and install them in the shaft with a driver. Make sure that they are only in the shaft far enough to permit installation of the cotter pin.
3. Assemble the rocker arms, springs and brackets in the sequence shown in Figure 13.

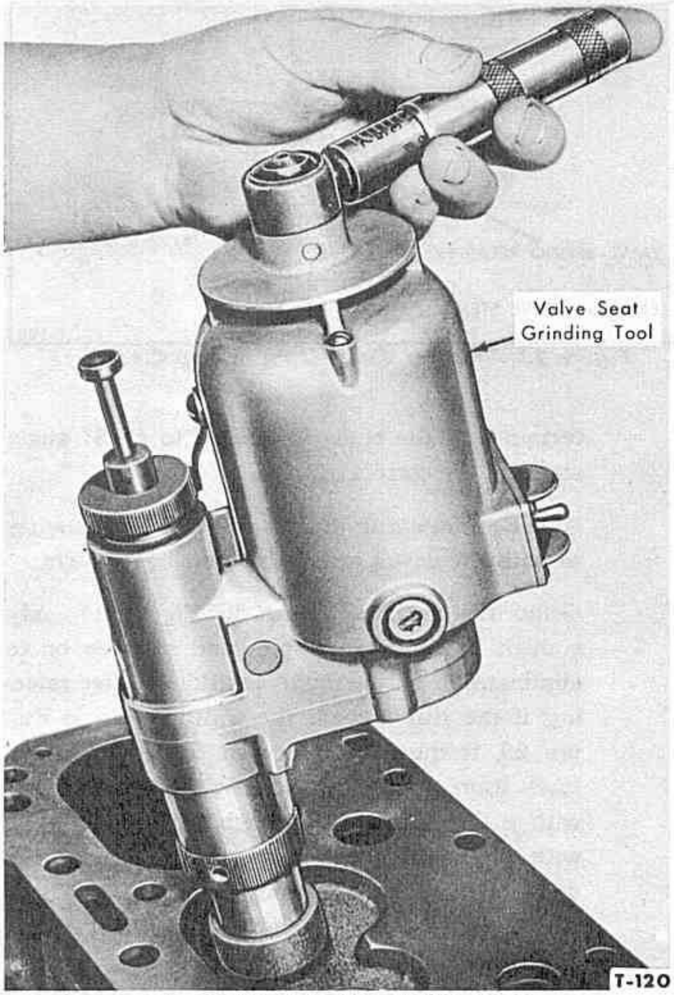


Figure 24—Grinding Valve Seats

NOTE: ***Diesel engines use six spacers to locate the rocker arms. Make certain that the two narrower spacers are installed at No. 3 support and the wider spacers are at No. 2 and 4 supports, Figure 13.***

4. Position a spring washer between two flat washers and position them on each end of the shaft. Secure the washers in place with cotter pins.

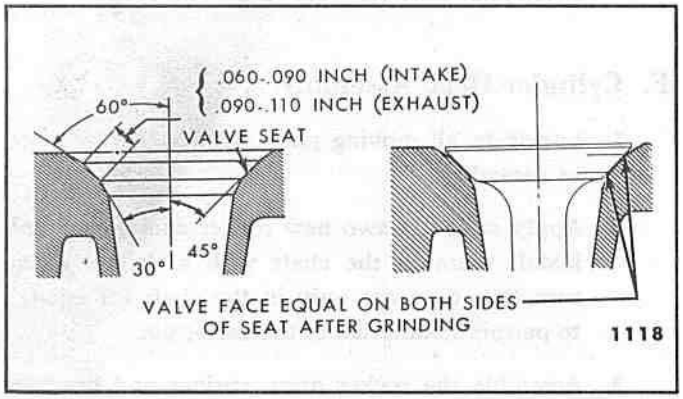


Figure 25—Valve Seat Width

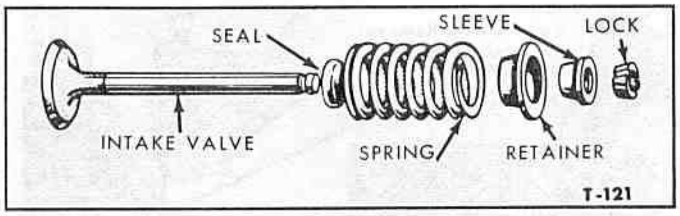


Figure 26—Intake Valve Assembly

NOTE: ***Diesel engines are not provided with washers. Use only the cotter pins to retain the rocker arms.***

5. Insert each valve in the guide from which it was removed. Position a new valve seal over each intake valve and guide.

6. Install the valve springs over the valve guides making sure the close wound coils are contacting the head.

NOTE: ***Place a valve spring spacer under each exhaust valve spring on diesel engines.***

7. Install the spring retainer sleeve as shown in Figure 26 on the intake valves. Install the spring retainer as shown in Figure 27, on the exhaust valves. Compress the spring with Valve Spring Compressor 6513-EE and install the valve locks, Figure 12.

8. Place the rotating cap that was previously selected on its respective valve (exhaust only).

9. Install the thermostat, water outlet elbow, and new gasket on the cylinder head.

G. Cylinder Head Installation

1. Place a new head gasket on the cylinder block then carefully position the cylinder head on the gasket. Install the cylinder head attaching bolts finger tight. If Cylinder Head Overhaul Fixtures 6085-F were used, remove them at this time.

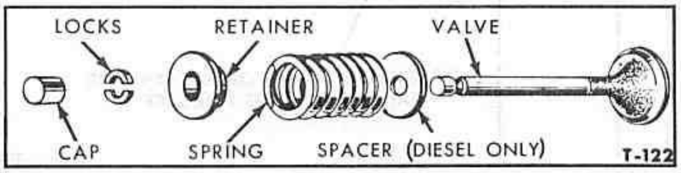


Figure 27—Exhaust Valve Assembly

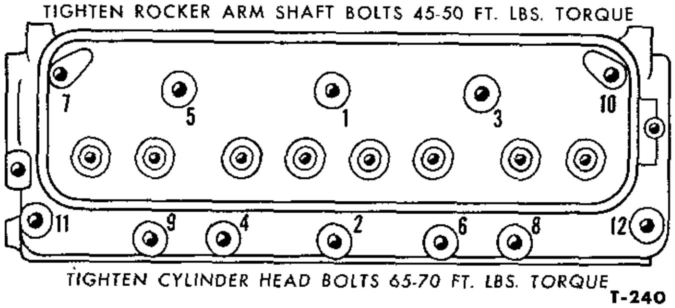

TIGHTEN ROCKER ARM SHAFT BOLTS 45-50 FT. LBS. TORQUE
7
5
1
3
10
11
9
4
2
6
8
12
TIGHTEN CYLINDER HEAD BOLTS 65-70 FT. LBS. TORQUE
T-240

Figure 28—Cylinder Head Tightening Sequence (Gasoline Engines)

2. Tighten the cylinder head bolts in the proper sequence and to the specified torque shown in Figures 28 and 29.

Diesel Engines:

a. Install the four fuel injectors with new seat washers in the cylinder head. Torque the attaching bolts to 15-18 ft. lbs. DO NOT USE A HAMMER TO SEAT THE INJECTORS.

b. Install the excess fuel line and fuel injector lines.

c. Install the fuel filter on the cylinder head.

Gasoline Engines:

a. Install the spark plugs with new gaskets in the cylinder head.

b. Connect the spark plug wires to their respective plugs. The firing order is 1-2-4-3.

3. Install the push rods with the cupped end upward.
4. Position the rocker arm in place on the cylinder head.
5. Install a new "O" ring on the oil inlet line. Install the inlet line in the cylinder block and rocker arm making sure it is free of the valve mechanism.
6. Install the rocker arm attaching bolts finger tight making sure that the ball end of the rocker arm adjusting screws are seated in the cupped end of the push rods. Tighten the rocker arm attaching bolts evenly and alternately to 45-55 ft. lbs. torque.

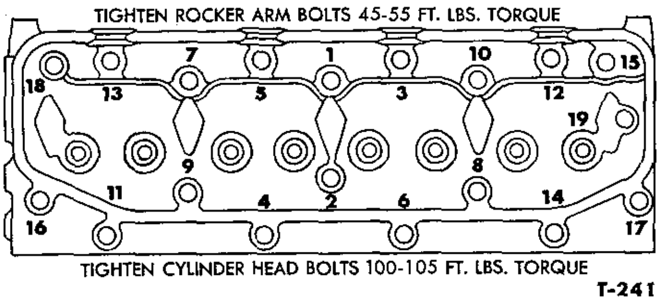
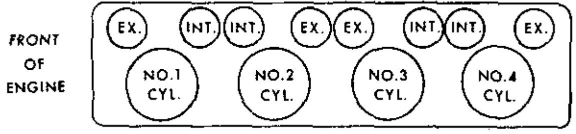

TIGHTEN ROCKER ARM BOLTS 45-55 FT. LBS. TORQUE
18
7
1
10
15
13
5
3
12
19
9
8
11
4
2
6
14
16
17
TIGHTEN CYLINDER HEAD BOLTS 100-105 FT. LBS. TORQUE
T-241

Figure 29—Cylinder Head Tightening Sequence (Diesel)



VALVE ARRANGEMENT CHART

Valves Open	Valves to be Checked
#1 Cyl. Exhaust & 3 Cyl. Intake	#2 Cyl. Intake & 4 Cyl. Exhaust
#1 Cyl. Intake & 2 Cyl. Exhaust	#3 Cyl. Exhaust & 4 Cyl. Intake
#2 Cyl. Intake & 4 Cyl. Exhaust	#1 Cyl. Exhaust & 3 Cyl. Intake
#3 Cyl. Exhaust & 4 Cyl. Intake	#1 Cyl. Intake & 2 Cyl. Exhaust

Figure 30—Valve Initial Adjustment Chart

7. Refer to Figure 30 and make an initial valve adjustment as indicated in the chart.
8. Install the intake and exhaust manifold and new gaskets. Connect the muffler to the exhaust manifold using a new gasket.
9. Connect the temperature gauge to the cylinder head.
10. Install the fuel tank. Install the air cleaner and tube. Install the hood.
11. Install coolant in the radiator.
12. Start the engine and allow it to run until it reaches normal operating temperature.
13. Adjust the tappets to 0.014-0.016 inch clearance as shown in Figure 31 while the engine is running at idle speed.

    NOTE: ***Later model engines have a self-locking adjustment screw, while the earlier models have an adjustment screw and lock nut.***

14. Install the rocker arm cover and new gasket. Tighten the cover nuts to 20-30 in. lbs. torque.

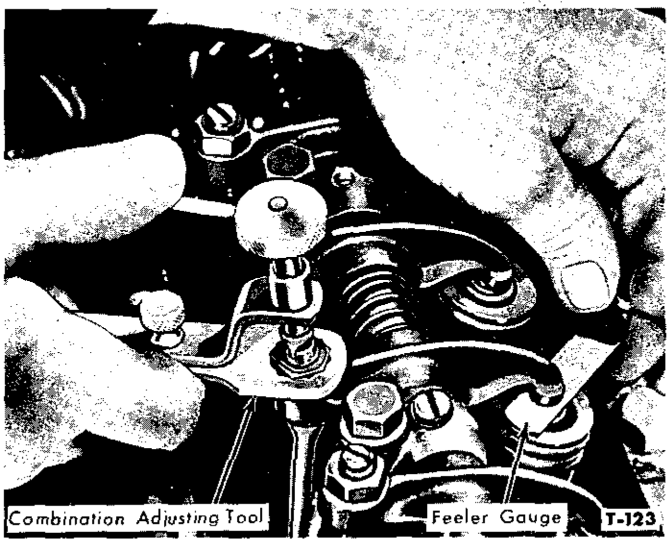


Figure 31—Adjusting Valve Tappet Clearance

4. OIL PAN, OIL PUMP AND OIL FILTER

The lubricating system used in all model Ford Tractor engines is shown in Figure 32. Oil is picked up from the sump by means of the oil pump and is pumped through the full flow oil filter. After leaving the filter, the oil moves through a drilled passage into the main oil gallery which extends the length of the cylinder block. The oil then flows under pressure to the main bearing journals, and through drilled passages in the crankshaft, to the connecting rod bearings. Oil also flows under pressure from the oil gallery to the camshaft bearing bosses. The camshaft is drilled at the center boss, so that each revolution of the camshaft lines up a set of holes allowing a spurt of oil to be pumped to the rocker arm shaft. Oil then fills the rocker arm shaft to lubricate the rocker arms. Oil dripping from the rocker shaft lubricates the valve stems, drains down through the push rod bores lubricating the tappets as shown in inset "A", Figure 32. The camshaft lobes, cylinder walls, and piston pins are lubricated by an oil spray from a spurt hole in the connecting rods as shown in inset "B", Figure 32. The camshaft gears and governor receive oil through a small metering hole as shown in inset "C", Figure 32.

NOTE: ***The governor is an integral part of the fuel injection pump on diesel engines and therefore is not in the timing gear cover, as in the gasoline engines.***

Crankshaft ventilation is accomplished by an expelling breather on the right side of the rocker shaft cover and an additional intake that is incorporated in the oil filler cap.

OIL PAN

A. Removal

1. Place a drain pan under the oil pan drain plug and remove the plug.
2. Remove the bolts that attach the pan to the cylinder block and remove the pan.

B. Inspection

1. Scrape all dirt and metal particles from the inside of pan. Scrape all gasket material from the mounting surface. Wash the pan in cleaning solvent and dry with a clean rag.
2. Inspect the pan for cracks, holes, damaged drain plug threads or damaged mounting surface. Repair all damage or replace the pan.
3. Clean the oil pan drain plug and screen thoroughly in cleaning solvent.

C. Installation

1. Apply a thin film of heavy grease to the oil pan mounting surface. Place a new gasket on the pan mounting surface.
2. Hold the pan in place on the cylinder block, then install the attaching bolts.
3. Place a new gasket on the oil pan drain plug and install the plug in the pan.
4. Fill the crankcase to the proper level with the specified grade of oil.

   NOTE: ***It is recommended that the oil filter or cartridge be changed after the pan has been cleaned.***
5. Start the engine and check for oil leaks.

OIL PUMP

A gear type oil pump is used on all model Ford Tractor engines. The pump is mounted on the right forward side of the engine inside the crankcase. The pump is driven by the distributor (gasoline) or fuel injection pump drive gear (diesel) through a short hexagon shaft. The oil pressure relief valve is incorporated in the pump body. The pump capacity is 3.5 gpm at 1400 engine rpm.

A. Oil Pump Removal

1. Remove the oil pan.
2. Remove the distributor or fuel injection pump.
3. Disconnect the oil filter inlet tube from the oil pump and the cylinder block, and remove the tube, gasket and seal.
4. Remove the two nuts and lockwashers that attach the pump to the cylinder block. Hold the pump, then pry the two tapered bolts out of the pump and cylinder block. Remove the pump and inlet tube as an assembly.

B. Oil Pump Disassembly

1. Remove the two bolts and washers that attach the oil inlet tube to the pump. Lift the tube, gasket, oil pump cover and cover gasket from the housing, Figure 33.
2. Lift the pump drive gear and shaft assembly and the driven gear out of the pump housing.
3. Remove the oil pump relief valve plug, the relief valve spring and the relief valve from the housing.
4. Clean all parts thoroughly in cleaning solvent and dry with compressed air.

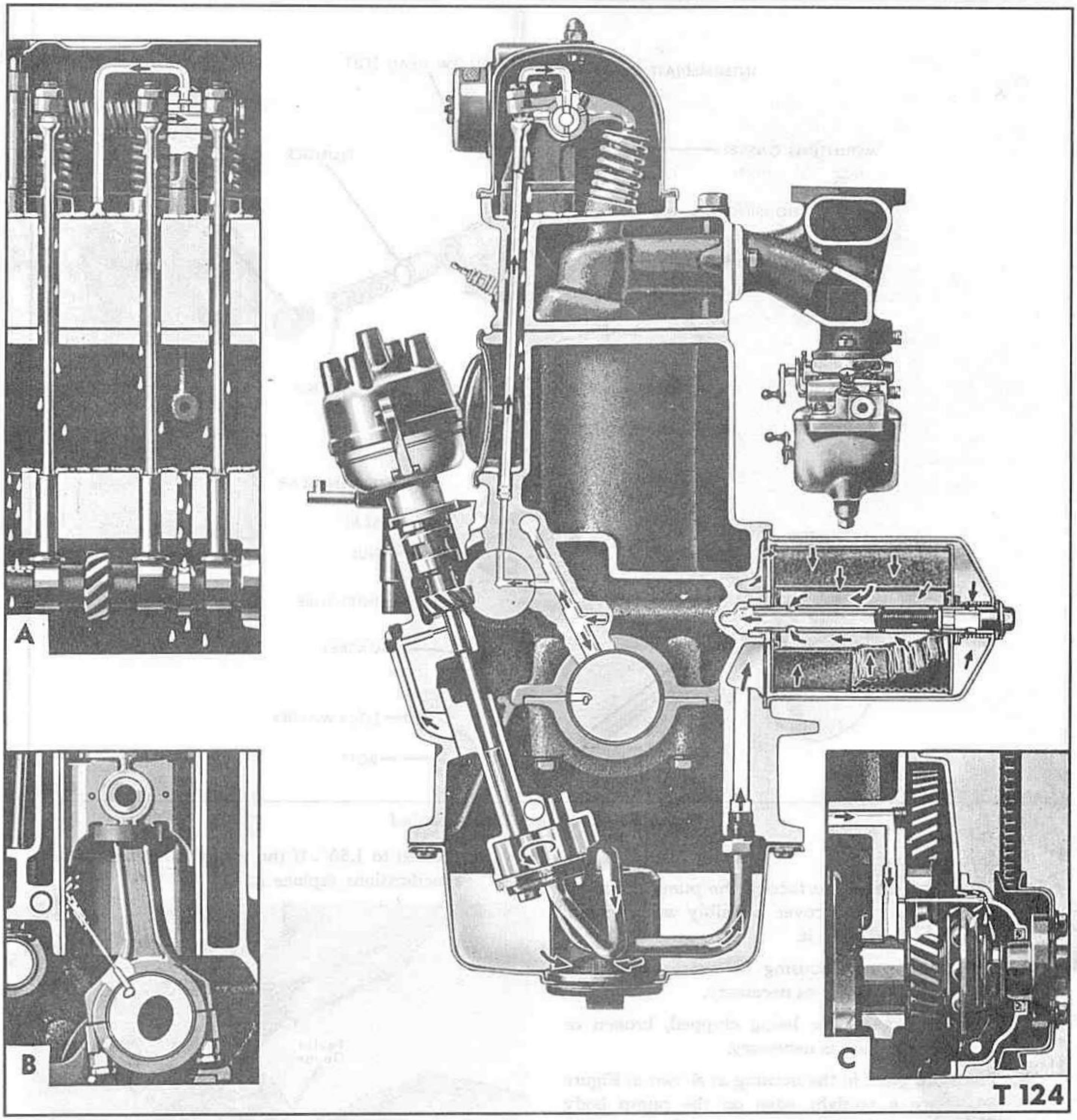


Figure 32—Engine Lubrication System

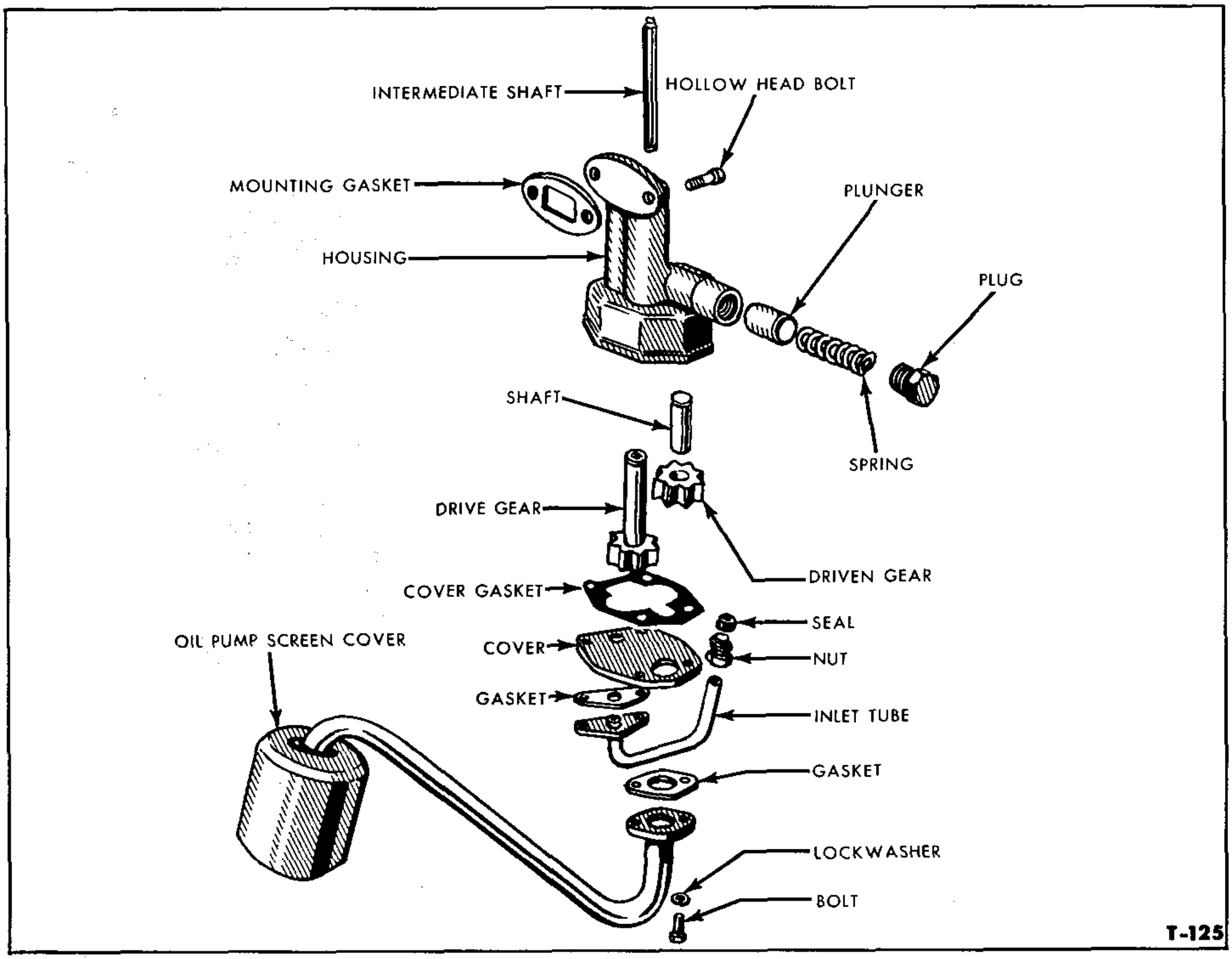


Figure 33—Oil Pump Disassembled

C. Inspection

1. Check the mating surface of the pump cover for wear. If the pump cover is visibly worn, scored, or damaged, replace it.
2. Check the pump housing for scores, cracks or damage and replace as necessary.
3. Check the gears for being chipped, broken or worn and replace as necessary.
4. Place the gears in the housing as shown in Figure 34. Place a straight edge on the pump body across the gears, then check the clearance with a feeler gauge. If the clearance exceeds 0.004″, replace the gears and/or housing.
5. Check the clearance between the gear teeth and housing. If the clearance exceeds 0.005″, replace the gears and/or housing.
6. Check the pressure relief valve spring tension. The pressure should be 9.76-9.84 lbs. when compressed to 1.56″. If the spring is not within these specifications replace it.

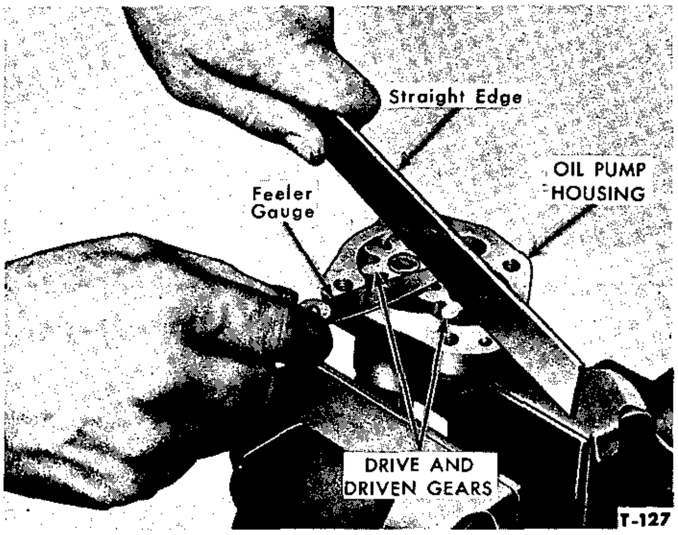


Figure 34—Checking Oil Pump for Wear

D. Assembly of Oil Pump

1. Oil all parts with engine oil.
2. Install the pump relief valve plunger, spring and plug in the oil pump housing, Figure 33.
3. Position the drive gear and shaft and the driven gear in the oil pump housing.
4. Install a new cover gasket and place the cover and the oil inlet tube on the housing. Install the two attaching bolts and lock washers.
5. Turn the drive gear shaft by hand to make certain that it turns freely.

E. Oil Pump Installation

1. Coat the pump housing to crankcase mounting surface with a light film of grease and position a new gasket on the housing.
2. Secure the oil pump to the crankcase with two hollow head bolts, nuts, and lock washers.

   NOTE: ***The hollow head bolts are of special design having tapered shoulders. The bolt heads must be on the outside of the crankcase.***
3. Connect the oil outlet line to the pump and cylinder block.
4. Install the oil pan.
5. Install the distributor or fuel injection pump.
6. Fill the crankcase to the proper level with the recommended oil. Start the engine and check for leaks.

F. Oil Pump Pressure Check

The engine oil pressure gauge indicates the pressure of the oil flowing to the bearings, but does not show the amount of oil in the crankcase. Oil in the crankcase can become dangerously low and pressure will still show on the gauge. Low oil pressure may be caused by a clogged oil pump screen, damaged oil pump, defective oil pressure relief valve, gauge, or worn bearings.

1. Disconnect the gauge pressure line at the gauge and connect a master gauge in its place.

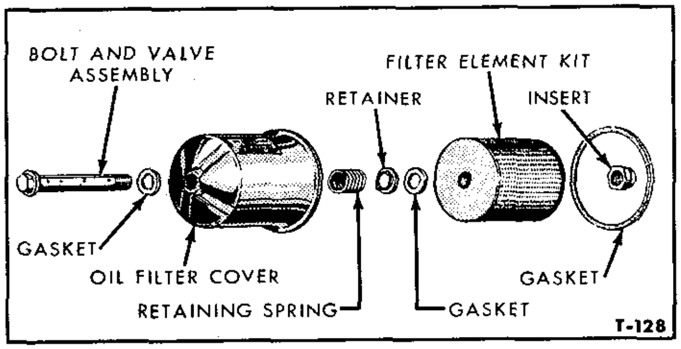


Figure 35—Early Type Oil Filter—Disassembled

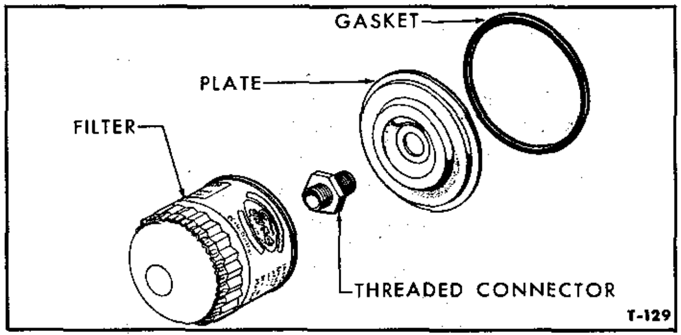


Figure 36—Later Type (Throw-Away) Oil Filter—Disassembled

2. After the engine has reached normal operating temperature, the oil pressure gauge should read approximately 40-45 psi at 1400 rpm, and not less than 8 to 10 psi at engine idle speed (475 rpm). Oil is thick when cold, therefore, oil pressure will be higher than normal when the engine is cold.
3. As the engine speed increases, the oil pressure will increase until the relief valve opens, and decreases when engine speed is decreased. Extremely low oil pressure at engine idle speed (475 rpm) is generally caused by worn bearings or oil pump gears.

OIL FILTER

There are two different type oil filters used on Ford Tractor engines. One type consists of a cover, filter element, center bolt and relief valve and the attaching parts and gaskets, Figure 35. The other consists of a mounting insert, adapter, gasket and oil filter, Figure 36. The later type (Throw-Away) contains the relief valve in the filter, whereas the relief valve was in the center bolt on the earlier type.

Both filters are of the full flow type, meaning that all of the oil in the crankcase must flow through the filter before entering the engine lubrication system.

When the filter is operating properly, oil flows through the filter into the hollow tube or center bolt then into the main oil gallery. Under this condition, the pressure at both ends of the bypass valve is equal, and the valve is closed. When the filter becomes clogged, pressure in the tube at the bottom of the valve becomes lower than at the top of the valve. When the pressure differential equals 7 psi, the valve opens, permitting the unfiltered oil to flow through the bypass valve and into the main oil gallery.

A. Oil Filter Removal

1. Place a pan under the filter to catch the small amount of oil that will drip down, then remove the center bolt and pull the filter away from the engine.

2. Remove the filter element, gaskets and spring. Discard the dirty element and gaskets and wash the housing, center bolt and spring in solvent. If the engine is equipped with a throw-away type filter, turn the filter counterclockwise until free of the mounting insert and remove the filter.
3. Clean all mounting surfaces thoroughly.

B. Oil Filter Installation

The oil filter used on row crop tractors is shorter than the one used on four wheel tractors, therefore, the cover and element are not interchangeable. The one throw-away type filter fits all model tractors equipped with a CPN-6882-A conversion kit. The following chart shows the element and cover part numbers for each type of tractor:

Tractor	Element	Cover
4 Wheel	C.P.N. 6731	6737
Row Crop	F.P.N. 6731	6715

1. Always use new gaskets when assembling the oil filter.
2. Assemble the filter for the four wheel tractors in the sequence shown in Figure 35. Assembly is the same for the row crop tractors, except that the bolt head is welded to the cover, making it one assembly.

   IMPORTANT: ***Use only one gasket between the spring seat and the filter element. The use of more than one gasket may result in restriction of the bypass port.***
3. Install the filter on the engine and tighten the center bolt to 20-50 ft. lbs. torque. If the engine is equipped with the throw-away type filter, turn the filter onto the mounting insert until the seal contacts the adapter then turn it one additional half turn.
4. Start the engine and check for oil leaks. Check the oil level and add as necessary to bring the level to the "FULL" mark on the dipstick.

C. Throw-Away Type Oil Filter Conversion Kit Installation

To convert from the early type oil filter to a throw-away type filter, proceed as follows:

1. Place a drain pan on the floor below the oil filter area.
2. Remove the center bolt and valve assembly, cover and element, Figure 35.
3. Place a 13/16″ bushing or washer on a ¾″ —16 x 3″ bolt and nut as shown in Figure 37. Thread the bolt into the insert in the cylinder block. Tighten the nut on the ¾″ bolt to seat the bushing against the insert. Turn the bolt counterclockwise to remove the insert from the cylinder block, Figure 37.

   NOTE: ***If the insert is provided with a hex head, remove it with a 1¼″ socket wrench.***
4. Clean the filter gasket area thoroughly.
5. Install the new large gasket, Figure 36, in the recess in the cylinder block. Hold the adapter against the gasket with the slot at the "TOP" and install the threaded connector as shown in Figure 38. Tighten the connector enough to seal the adapter to the cylinder block.
6. Thread the oil filter onto the connector until the filter seal contacts the adapter, then turn the filter an additional half turn.

   IMPORTANT: ***Do not overtighten the filter.***
7. Start engine and check filter for oil leaks.
8. Check the engine oil level and add oil as necessary.
9. Remove the drain pan from under the tractor.

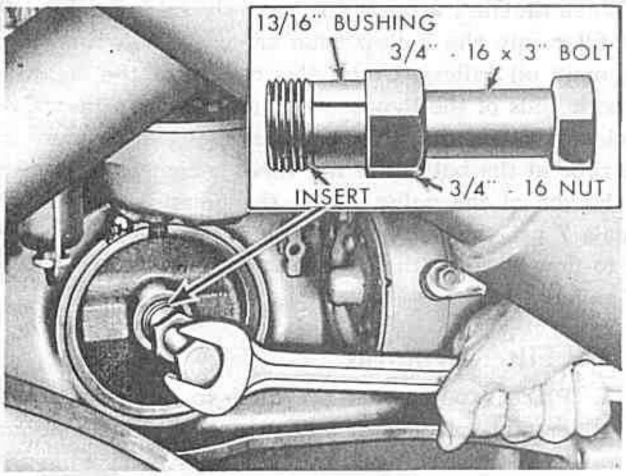


Figure 37—Removing Insert from Cylinder Block

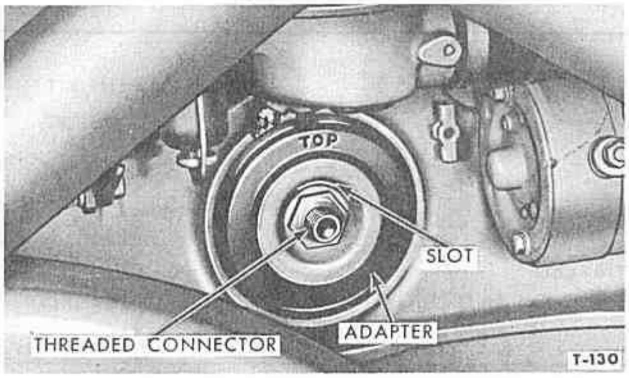


Figure 38—Connector and Adaptor Installed

5. CONNECTING ROD, BEARINGS, PISTONS, RINGS AND CYLINDER BLOCK

This section outlines the removal, inspection and installation procedures for connecting rods, pistons and pins. Complete data is given on the fitting of connecting rod bearings and the fitting of new rings, pistons and preparing the cylinder block for oversize pistons.

PISTON AND CONNECTING ROD ASSEMBLY

A. Removal

1. Remove the cylinder head and the oil pan from the engine.
2. Remove the ridge from the top of each cylinder with Cylinder Ridge Reamer 6011-E, see Figure 39.

   NOTE: ***Do not attempt to remove a piston and connecting rod from the cylinder without first removing the ridge. Forcing the pistons past the ridge may break the lands on the pistons.***

3. Remove the oil pump from the engine. If the engine is equipped with a balancer, remove it from the crankcase.
4. Turn the crankshaft until a piston is at the bottom of the stroke, then remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out of the top of the cylinder with the handle end of a hammer. Do not scratch the crankpin or the cylinder wall when removing the piston and rod. Repeat this procedure for each piston assembly.

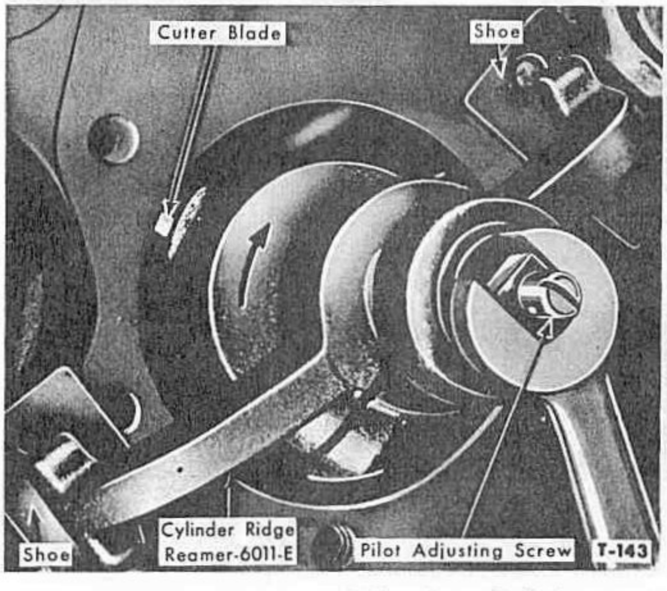


Figure 39—Removing Ridge From Cylinder

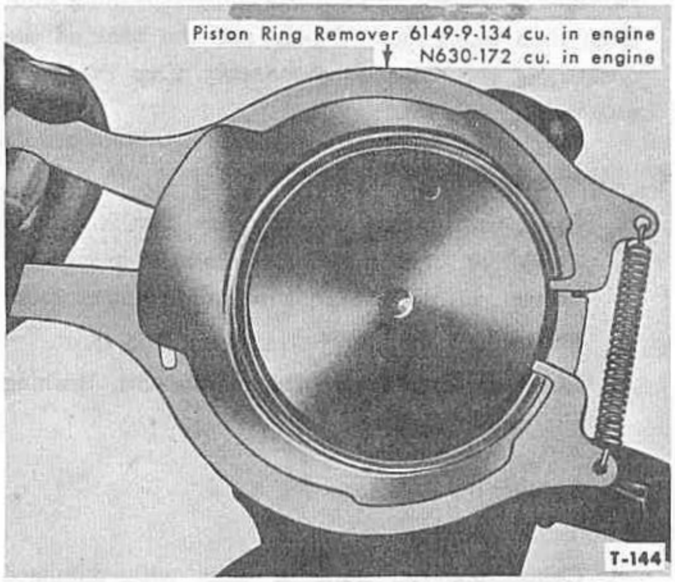


Figure 40—Removing Piston Rings

   NOTE: ***Keep the connecting rod bearing caps and bearings with their respective rods.***

5. Remove the piston rings from the pistons with Piston Ring Expander 6149-9 for gasoline or LP-Gas engines or N-630 for diesel engines, see Figure 40.

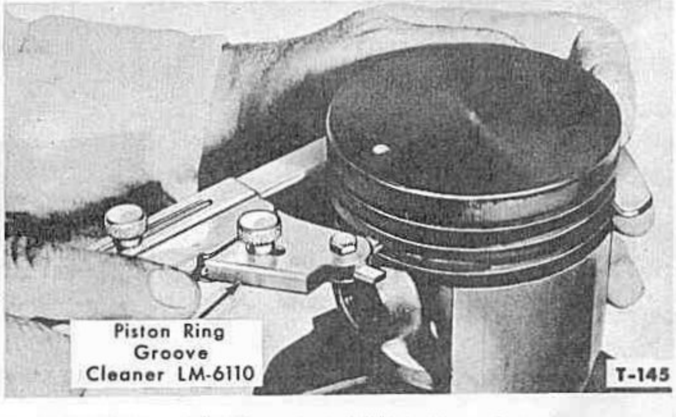


Figure 41—Cleaning Piston Ring Grooves

B. Cleaning

Clean the piston ring grooves with Piston Ring Groove Cleaner, LM-6110, Figure 41. Clean all the passages in solvent (do not use caustic cleaning solution) then clean the rod bore and the back of the connecting rod bearings thoroughly. Dry the parts with compressed air.

C. Disassembly

1. Mark each piston to make sure that it will be assembled on the rod from which it was removed. Remove the piston pin retainer from each side of the piston.
2. Drive the pin out of the piston with Bushing Driver Set 818.

D. Inspection

Connecting Rods:

1. Connecting rod bolts or nuts with damaged threads, and rods with deep nicks, signs of fractures, scored bores, or bores out of round more than 0.002″, should be replaced.
2. Use a new piston pin to check the piston pin bushing in the connecting rod for wear. The pin should have a 0.0001″-0.0003″ clearance in the rod bushing. If a new pin falls through a dry bore by its own weight, replace the bushing and ream it to fit the new pin.

Connecting Rod Bearings:

1. Replace bearing inserts that are scored, have the overlay wiped out, show fatigue failure, or that are badly scratched as shown in Figure 42.
2. If the bearings appear to be serviceable, they will have to be checked for clearance when installing the rods in the engine. If the clearance exceeds the specified limits (see section 11, page 54) the bearing must be replaced. Connecting rod bearing inserts are available in 0.001″-0.002″-0.010″ and 0.020″ undersize.

Pistons:

1. Inspect pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands by using new rings and a feeler gauge as shown in Figure 43. The rings should have the following clearance:

Ring		Ring Side Clearance
Top Compression	Gasoline Engines	0.0020-0.0035 In.
2nd Compression		0.0020-0.0035 In.
Oil Ring		0.0015-0.0030 In.
Top Compression	Diesel Engines	0.004-0.0055 In.
2nd and 3rd Compression Upper and Lower		0.002-0.0035 In.
Oil Rings		0.0015-0.0030 In.

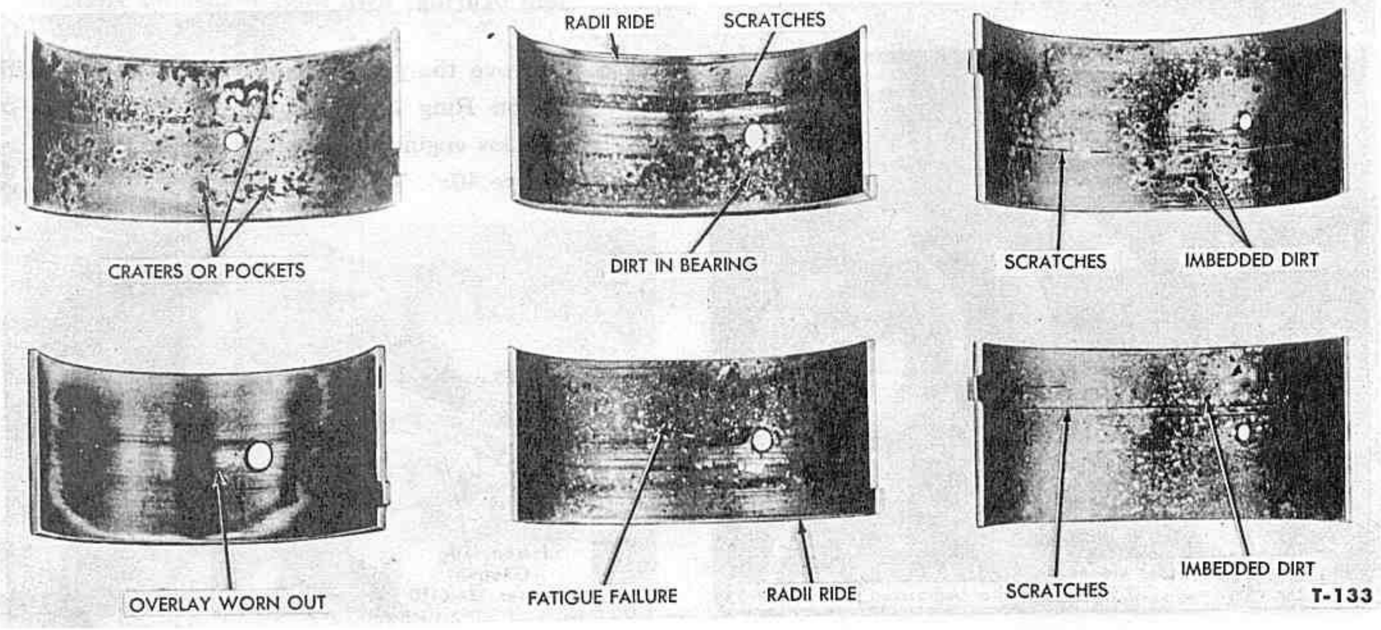


Figure 42—Defective Bearings

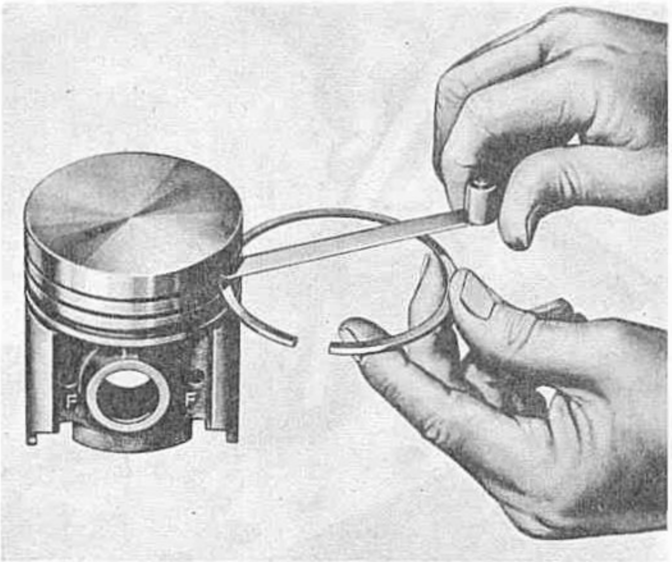


Figure 43—Checking Ring Side Clearance

2. Replace pistons showing signs of excessive skirt clearance, wavy ring lands, worn ring lands, fractures or damage from detonation. Spongy, eroded areas near the edge of the piston top are caused by detonation. In some instances, severe detonation causes holes to be burned through the top of the piston.

3. Replace piston pins showing signs of fractures or etching. Piston pins that show wear or that fit loosely in the piston or rod bushing, should be replaced. Replace all piston pin retainers.

E. Repair

Connecting Rod Bushing Replacement:

1. Press the old bushing out of the connecting rod with Bushing Driver 818 (gasoline engines) or Bushing Driver T-818 (diesel engines).

2. Carefully press a new bushing into the connecting rod with the same bushing driver that was used when removing the old bushing.

3. Using the existing hole in the top of the connecting rod as a guide, drill a 0.187" diameter hole in the bushing. Ream the bushing with Connecting Rod Bushing Reamer 6207-D to obtain

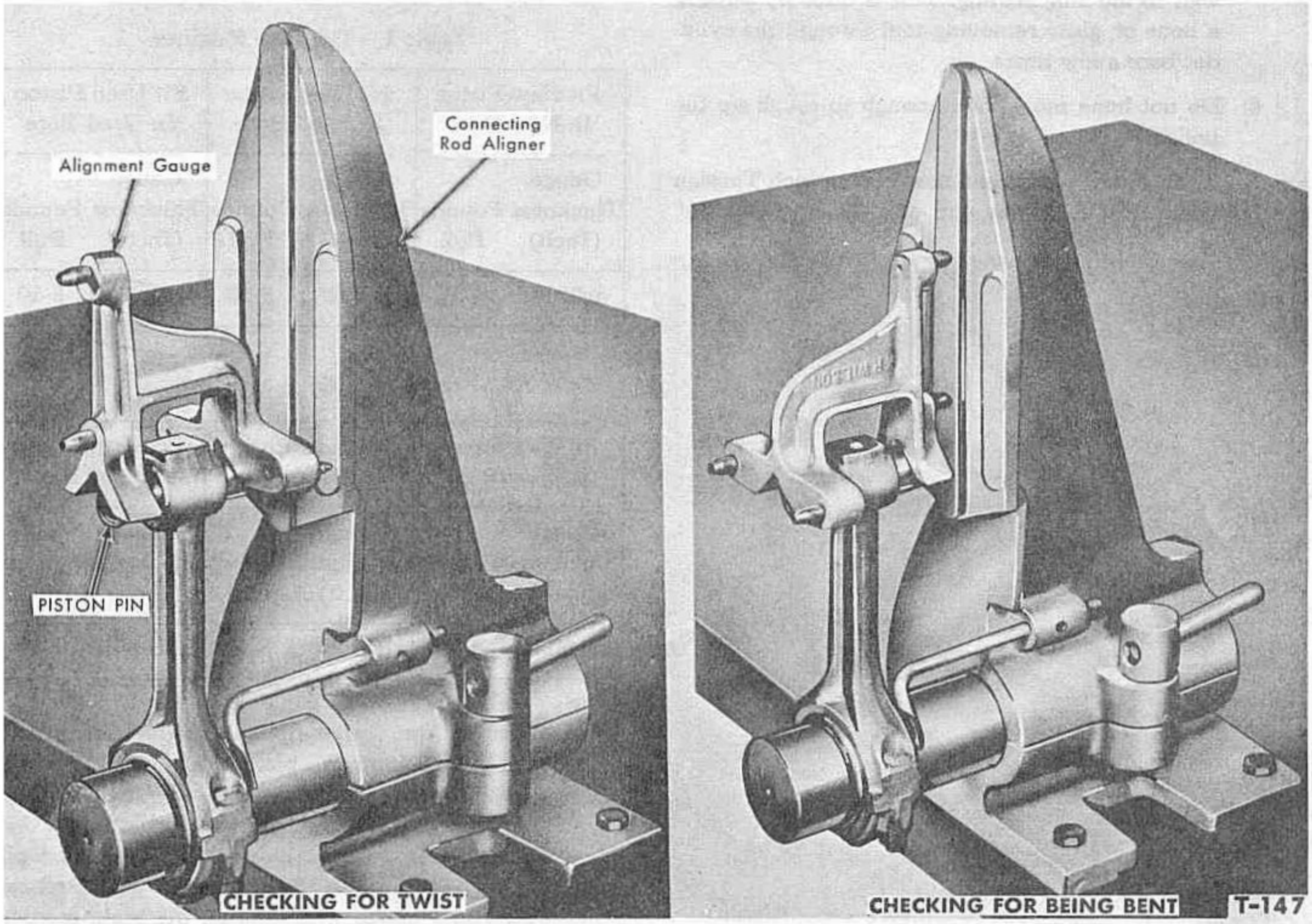


Figure 44—Checking Connecting Rod Alignment

0.0001-0.0003" clearance between the bushing and piston pin (gasoline engines).

4. Ream the bushings in diesel connecting rods to obtain a clearance of 0.0002-0.0008" with an expansion reamer.

Connecting Rod Alignment:

1. Place the connecting rod in an alignment fixture as shown in Figure 44.
2. If the connecting rod is twisted more than 0.012" or bent more than 0.004" it should be straightened or replaced.

Fitting Pistons:

1. Proper piston tolerances must be maintained if satisfactory engine operation is to be obtained.
2. Cylinder bores must be checked for taper and out of round condition before fitting a piston.
3. Before installing a piston and new rings in a used block, remove the high polish on the cylinder wall to aid ring seating. This is done by passing a hone or glaze removing tool through the cylinder bore a few times.
4. Do not hone more than enough to rough up the polish.
5. To fit a new piston in a new bore, attach Tension Scale, 3600-E to the end of a feeler ribbon ½" wide and having the correct thickness as outlined in the following tables.

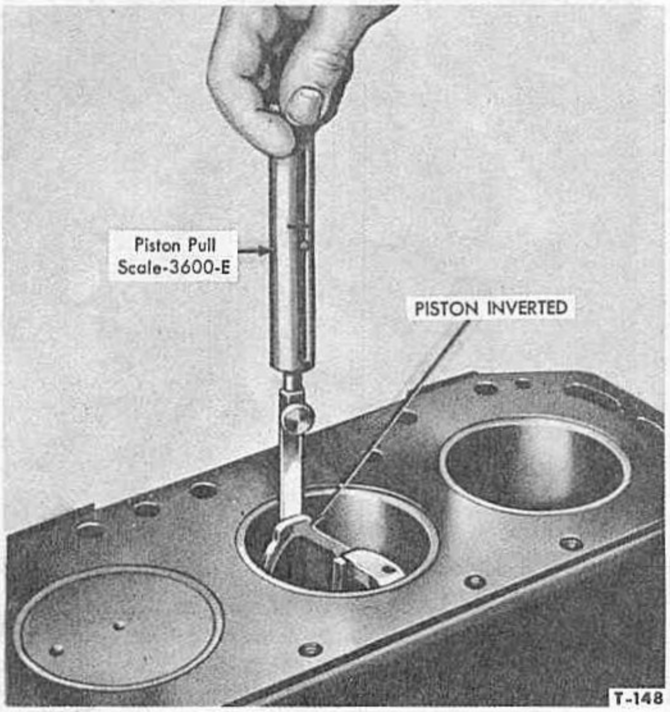


Figure 45—Fitting Pistons

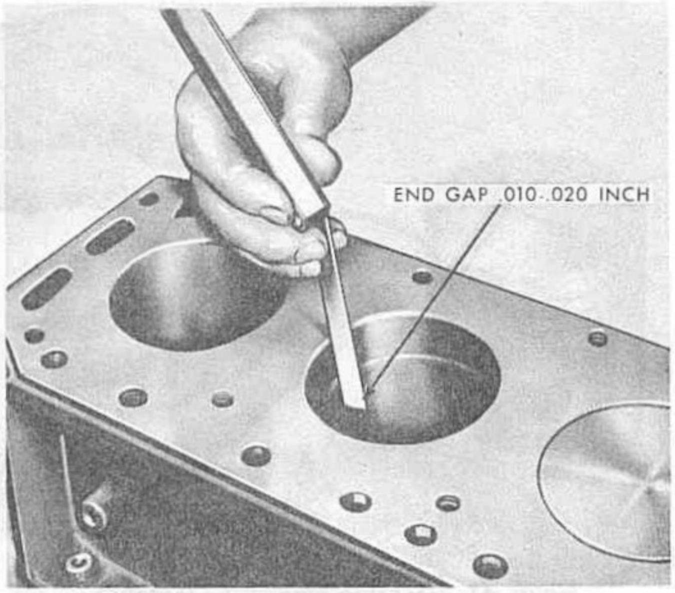


Figure 46—Checking Piston Ring End Gap

Table I – Gasoline Engines

Fit New Piston In New Bore		Fit New Piston In Used Bore		Fit Used Piston In Used Bore	
Gauge Thickness (Inch)	Pounds Pull	Gauge Thickness (Inch)	Pounds Pull	Gauge Thickness (Inch)	Pounds Pull
0.0015	5-10	0.002	5-10	0.003	5-10

Table II – Diesel Engines

Fit New Piston In New Bore		Fit New Piston In Used Bore		Fit Used Piston In Used Bore	
Gauge Thickness (Inch)	Pounds Pull	Gauge Thickness (Inch)	Pounds Pull	Gauge Thickness (Inch)	Pounds Pull
0.005	5-10	0.006	5-10	0.007	5-10

6. Position the feeler ribbon on the side of the piston 90° from the piston pin hole. Invert the piston, then push the piston and feeler gauge into the cylinder so that the end is about ½" below the top of the block. Keep the piston pin bores parallel with the crankshaft axis. Pull out the feeler gauge while noting the scale reading, see Figure 45.

7. The pull limits for new pistons and used pistons in new or used bores are given in Tables I and II.
8. If the scale reading is greater than the maximum allowable pull, try another piston or hone the cylinder bore to obtain the proper fit. If the scale reading is less than the minimum allowable pull, try another piston. If none can be fitted, rebore the cylinder sleeve to the next oversize piston.

Fitting Piston Rings:

1. Install the piston ring in the cylinder bore. Invert the piston and push the ring approximately halfway into the bore to true the ring with the cylinder bore. Measure the ring end gap with a feeler gauge as shown in Figure 46.
2. The gap should be 0.010"-0.020" for all rings. If the gap is less than the minimum limit, remove the ring and file the ends in a fixture (commercially available) until the proper clearance is obtained. After the rings have been fitted in the cylinder bore, they should be identified with the piston and cylinder bore in which they are to be installed.

Fitting Connecting Rod Bearings—Plastigage Method:

1. Place a piece of the correct size Plastigage plastic across the length of the insert or journal. Install the bearing cap and tighten the nuts to 45-50 ft. lbs. torque.

   NOTE: ***Do not turn the crankshaft with the Plastigage in place.***

2. Remove the bearing cap and use the Plastigage scale to measure the width of the flattened plastic at the widest point as shown in Figure 47.
3. If reading is within limits, (see Section 11) the fit is satisfactory. Fit the remaining connecting rod bearings in the same manner.

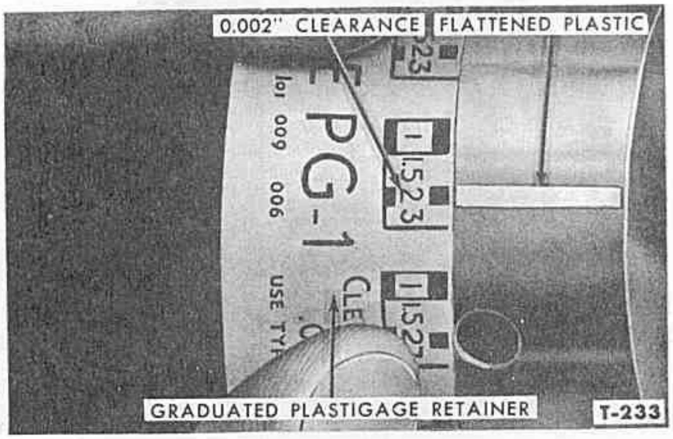


Figure 47—Measuring Flattened Plastigage

F. Assembly

1. Lubricate all parts with engine oil.
2. Position a piston on its respective connecting rod as shown in Figure 48 and install the piston pin. Install two new piston pin retainers, see Figure 49.

   NOTE: ***The piston must be assembled on the connecting rod so that the indentation is toward the front of the engine while the oil squirt hole in the rod is toward the camshaft side of the engine.***

3. Install the rings on the pistons in accordance with the instructions contained in the piston ring carton. Use Piston Ring Expander 6149-9 (gasoline or LP-Gas engines) or N-630 (diesel engines), see Figure 40, to prevent distorting or breaking the rings.

G. Installation

1. Turn the crankshaft to position No. 1 crankpin at the bottom of its stroke.
2. Lubricate the rings on No. 1 piston with engine oil. Compress the rings with Piston Ring Compressor FLM-6149 (gasoline or LP-Gas engines) or 850-T (diesel engines), as shown in Figure 50. Install the bearing inserts in the rod if not already installed.
3. Position the piston and rod assembly in the cylinder block with the indentation facing toward the front of the engine.

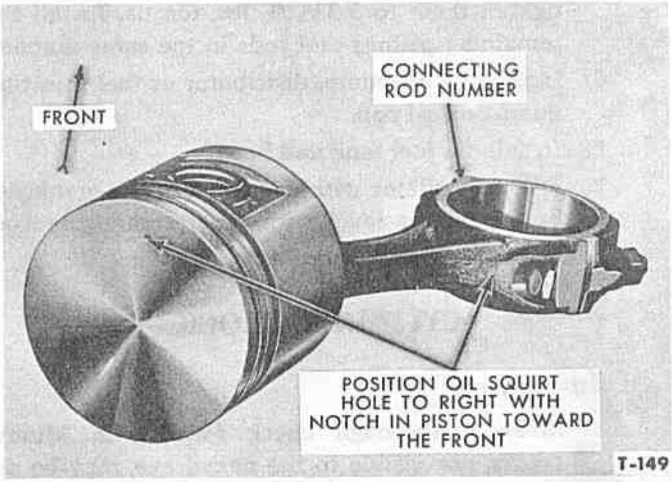

FRONT
CONNECTING ROD NUMBER
POSITION OIL SQUIRT HOLE TO RIGHT WITH NOTCH IN PISTON TOWARD THE FRONT
T-149

Figure 48—Correct Position of Piston in Relation to Connecting Rod

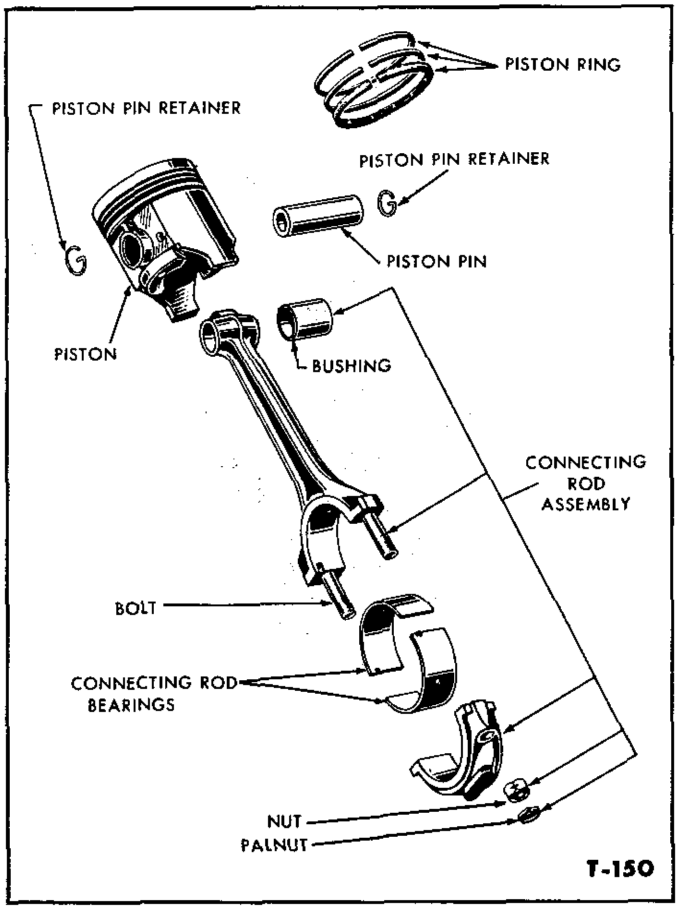


Figure 49—Piston and Connecting Rod Disassembled

4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the crankpin. Install the bearing cap on the rod with the cylinder number facing opposite the camshaft side of the engine. Install and tighten the nuts to 45-50 ft. lbs. torque. Install two new Pal nuts on the connecting rod and tighten them to 3-3½ ft. lbs. torque. Install the remaining pistons and rods in the same manner.
5. Install the oil pump, distributor or fuel injection pump and oil pan.
6. Install the fuel tank and hood.
7. Fill the radiator with coolant. Fill the crankcase to the proper level with the recommended oil.
8. Start the engine and check for leaks.

CYLINDER BLOCK

A. Inspection

1. Make a thorough check for cracks. Minute cracks, not visible to the naked eye, may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light motor oil. Wipe the part dry and immediately apply a white coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area.
2. Inspect the cylinder bores for scoring. Inspect the expansion plugs for rust at the edge of the plug. Rust indicates leakage. If leakage is indicated, replace the plug.
3. Check the cylinder bore for taper, out of round and wear, with a cylinder bore gauge, telescope gauge, or inside micrometers, see Figure 51.
4. Record measurements taken lengthwise and crosswise at the top and bottom of the piston ring travel, as follows:
   a. Lengthwise of the block, measure and record as "A" the diameter of the cylinder at the top of the cylinder where the greatest ring wear occurs.
   b. Also, lengthwise of the block, measure and record as "B" the cylinder diameter at the bottom of the piston skirt travel.
   c. Crosswise of the block, measure and record as "C" the diameter of the top of the cylinder at the greatest wear point.
   d. Measure and record as "D" the diameter at the bottom of the cylinder bore, and crosswise of the block.
   e. Reading "A" compared to reading "B" and reading "C" compared to reading "D", indicates cylinder taper.
   f. If cylinder taper exceeds 0.008", rebore the sleeve to accommodate the next oversize piston. Reading "A" compared to reading "C"

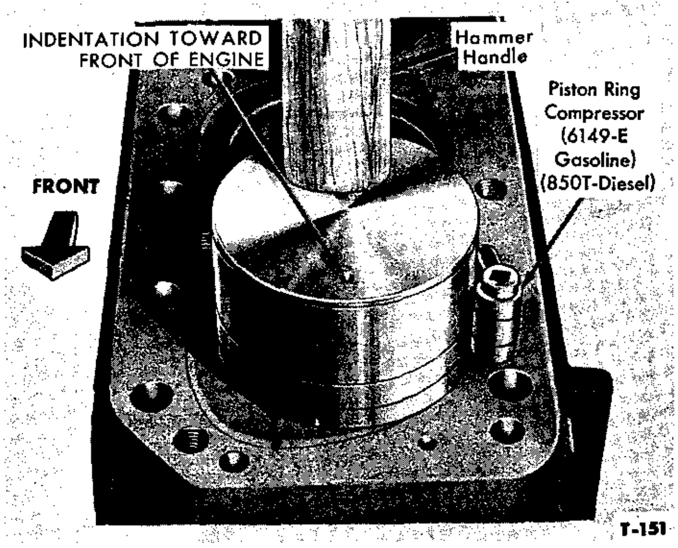

INDENTATION TOWARD FRONT OF ENGINE
Hammer Handle
Piston Ring Compressor (6149-E Gasoline) (850T-Diesel)
FRONT
T-151

Figure 50—Installing Piston and Connecting Rod

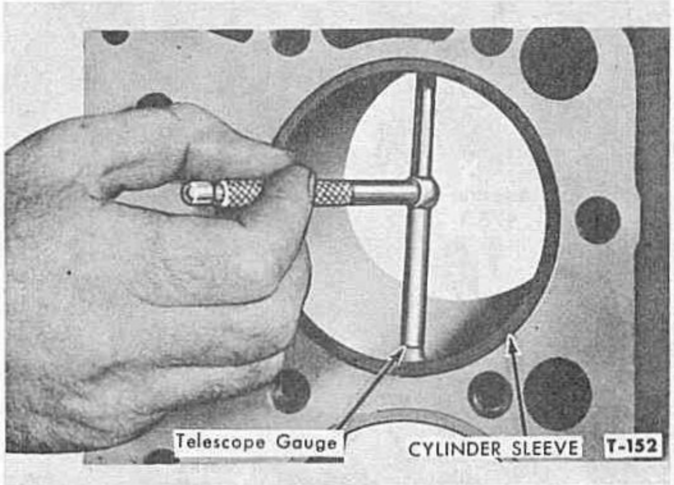


Figure 51—Measure Cylinder Sleeve Bore

and reading "B" compared to reading "D", indicates whether or not the cylinder is out of round. If the out of round exceeds 0.003" the cylinders must be rebored and honed for the next oversize piston. Replacement pistons are available in standard, 0.020", 0.030" and 0.040" oversize.

B. Repair

Boring Cylinder Sleeve:

1. To provide maximum engine performance and perfect balance of the reciprocating parts of the engine, all cylinder sleeves must be bored to the same size when oversize pistons are installed, even though only one cylinder requires reboring and the others are within tolerance. Manufacturers' recommendations on how to use boring equipment should be followed and the work should be performed by experienced personnel.
2. Bore the cylinder with the most wear first, to determine the proper oversize. If the cylinders will not clean up at 0.040" oversize, the sleeve must be replaced. When reboring sleeves, allow 0.0015" stock for honing to a final finish. Use a number 220 to 280 grit hone for this operation.

Cylinder Sleeve Removal:

1. Install Cylinder Sleeve Puller FT-970 on the cylinder block as shown in Figure 52.
2. Turn the screw clockwise until the sleeve is free of the cylinder block.

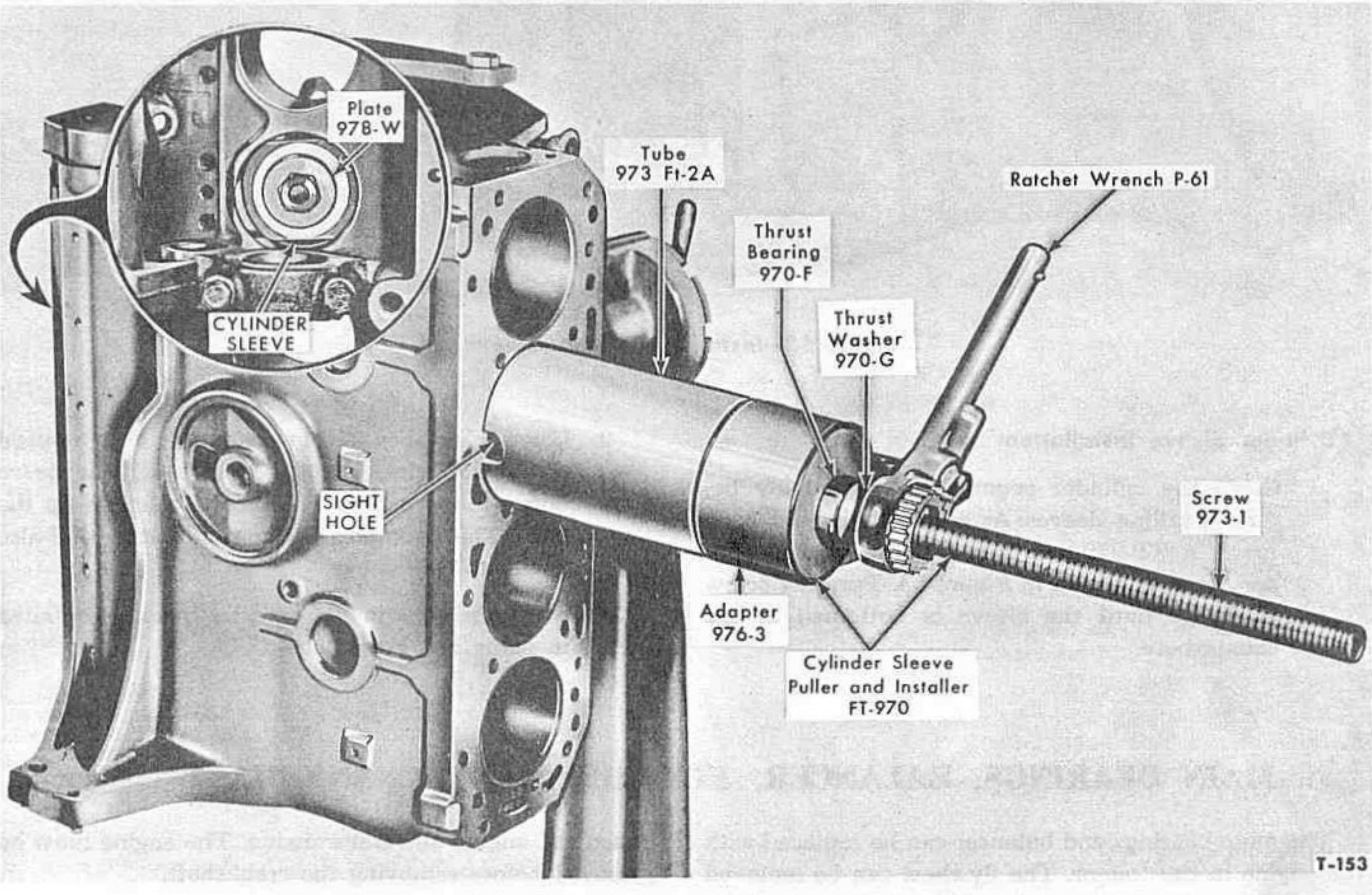


Figure 52—Removing Cylinder Sleeve

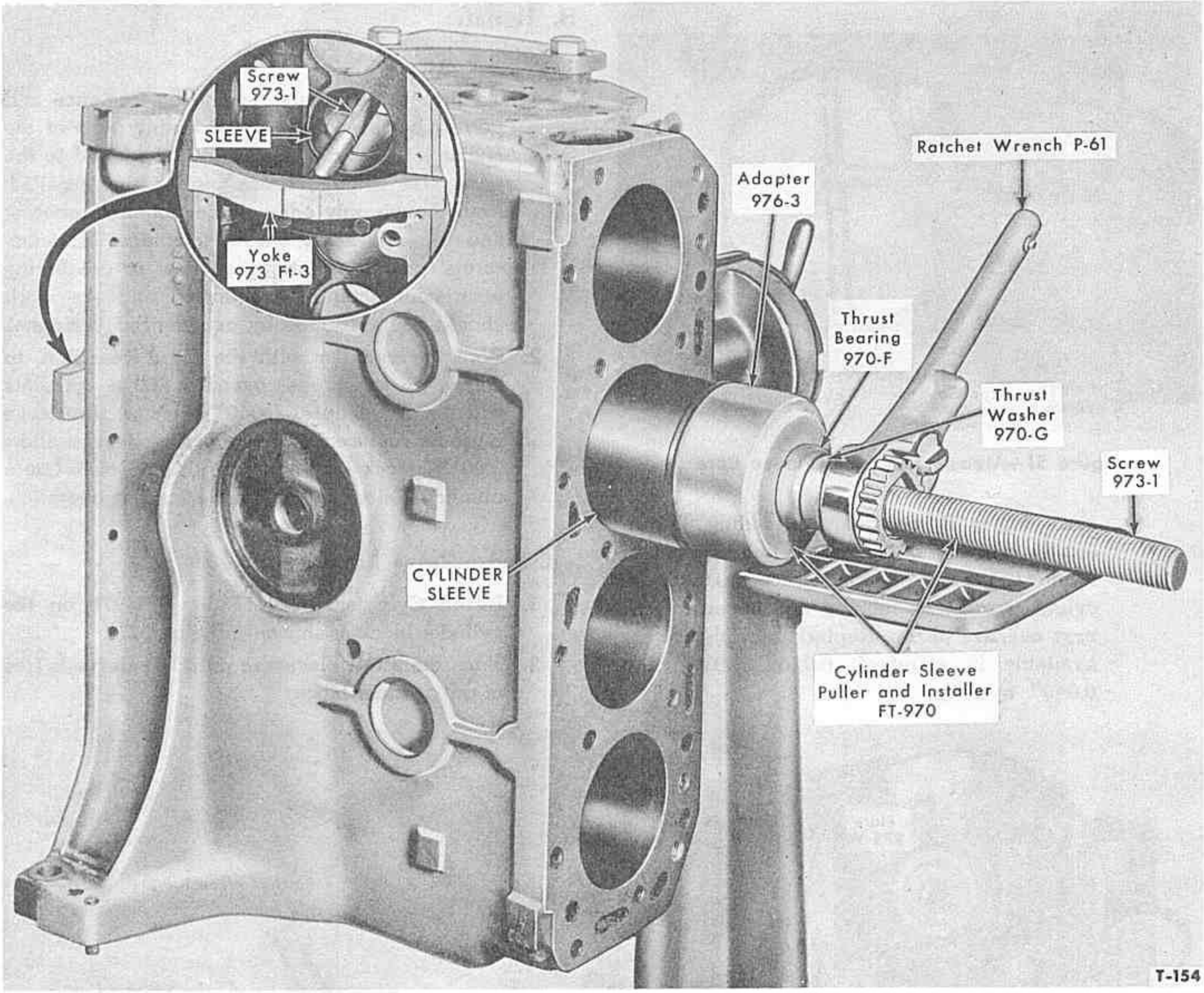


Figure 53—Installing Cylinder Sleeve

Cylinder Sleeve Installation:

1. Clean the cylinder counterbore thoroughly before installing sleeves. Assemble Cylinder Sleeve Installer FT-970 and a new sleeve on the cylinder block as shown in Figure 53. Turn the screw clockwise until the sleeve is bottomed in the counterbore.
2. Using a number 220 grit stone at a drill speed of 250-450 rpm, pass a hone through the sleeve bore not more than 10 times to roughen up the bore. This promotes better ring seating and also "trues up" the sleeve.
3. Fit the pistons in the cylinder block as detailed in paragraph E on page 28.

6. MAIN BEARINGS, BALANCER, FLYWHEEL AND CRANKSHAFT

The main bearings and balancer can be replaced with the engine in the tractor. The flywheel can be removed by removing the engine or by splitting the tractor between the engine and transmission. The engine must be removed before removing the crankshaft.

MAIN BEARINGS

A. Removal

1. Remove the oil pan and oil pump.

   NOTE: ***On engines equipped with a balancer, remove the balancer as detailed in Balancer removal on page 35 to gain access to the bearing caps.***

2. Remove the two bolts that attach the main bearing cap to the cylinder block and remove the cap and bearing. Install a bearing insert remover in the oil passage of the crankshaft as shown in Figure 54. Turn the crankshaft counterclockwise slowly until the tool forces the bearing out of the cylinder block.

   NOTE: ***If a bearing insert tool is not available, flatten the head of a 1" x ⅛" cotter pin and bend the head at approximately a 30° angle to conform to the angle of the oil passage in the crankshaft, see Figure 55. Use the fabricated tool in the same manner to remove and install bearing inserts. The shorter cotter pin must be used to remove the center main bearing insert.***

B. Inspection

Clean the bearing inserts, journals and cap thoroughly. Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of bearing failures and their causes are shown in Figure 56. Check the clearance of bearings that appear serviceable with Plastigage, following the recommended procedure.

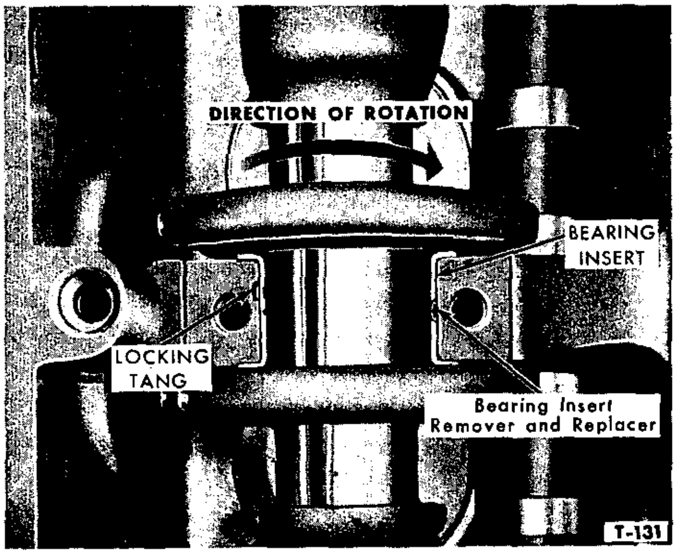


Figure 54—Removing Main Bearing Insert

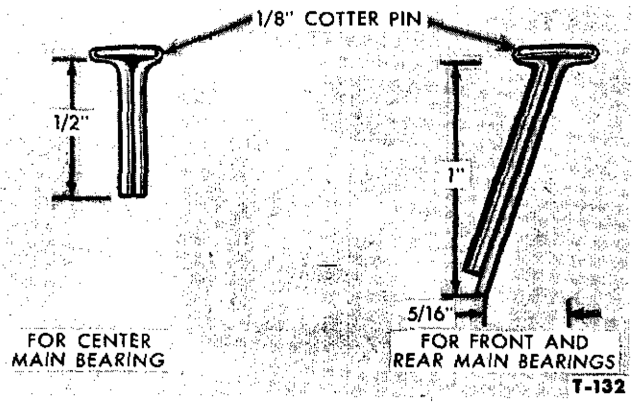


Figure 55—Fabricated Main Bearing Insert Tool

C. Fitting Main Bearings (Plastigage Method)

1. Remove the oil pan and oil pump. Remove a main bearing cap and wipe the oil from the bearing and crankshaft journal.

   NOTE: ***If the bearings are being fitted with the engine in the tractor, a jack should be used adjacent to the bearing being fitted to hold the crankshaft up against the upper main bearings.***

2. Place a piece of the correct size Plastigage the full width of the bearing journal, if the engine is inverted. Place the Plastigage in the bearing cap, if the engine is in the normal operating position. Install the bearing cap and tighten the retaining bolts to 95-105 ft. lbs. torque (gasoline or LP-Gas engines) or 110-115 ft. lbs. torque (diesel engines).

   IMPORTANT: ***Do not turn the crankshaft while the Plastigage is between the bearing and the journal.***

3. Remove the bearing cap. Without moving the plastic, check its width at the widest point with the graduations on the Plastigage container, as shown in Figure 57.

   NOTE: ***Normally, main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out of round journal, be sure to fit the bearing to the maximum diameter of the journal.***

4. If the bearing is fitted to the minimum clearance of 0.0005" (babbitt) or 0.0019" (copper lead) on the minimum diameter of the journal, and the journal is out of round 0.0005" or more, interference between the journal and bearing will result in rapid failure of the bearing.

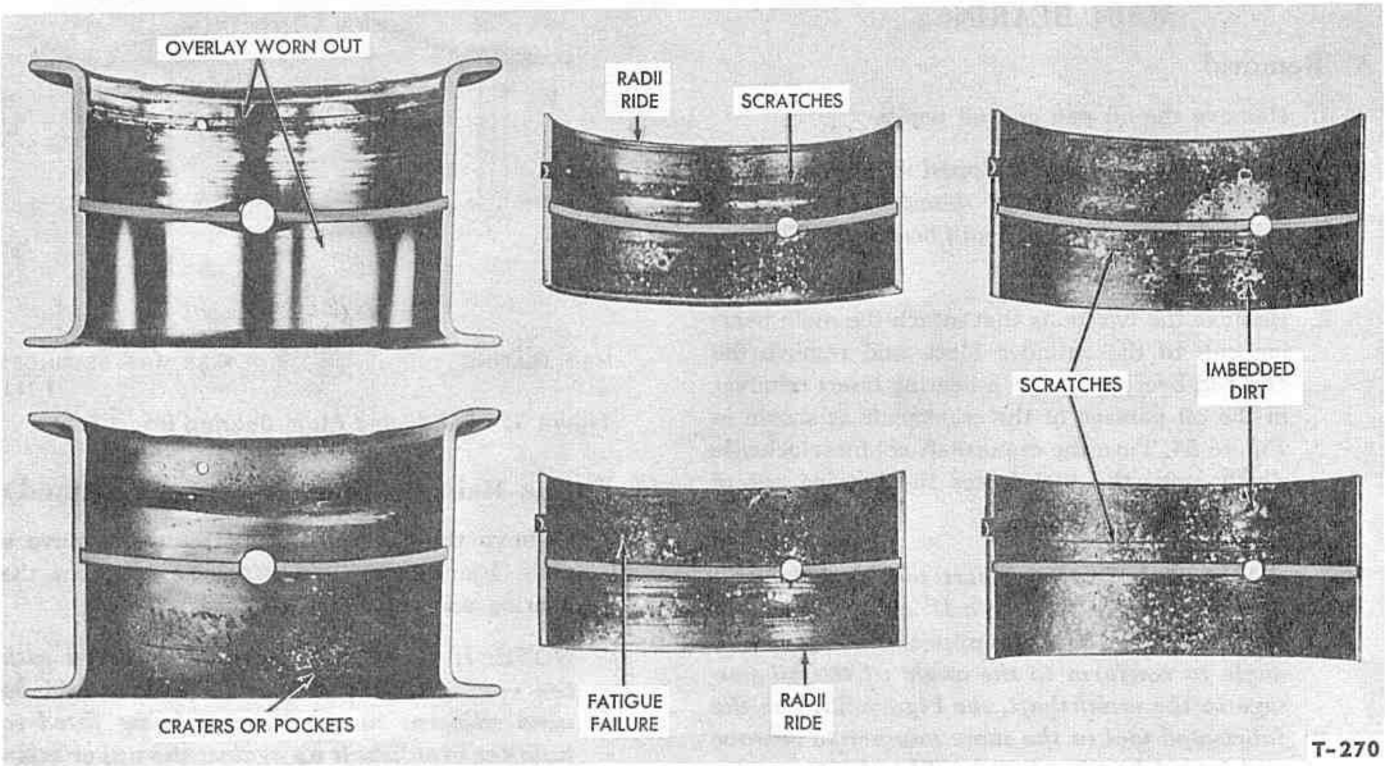


Figure 56—Bearing Failures—Typical

5. If the clearance is not within limits, try the selective fit undersize bearings to bring the clearance within limits, see Section 11. If the selective fit undersize bearings do not bring the clearance within limits it will be necessary to regrind the crankshaft journals for use with the next undersize bearing.

   NOTE: ***If the flattened plastic is not uniform in width from end to end, the journal or bearing is tapered. Be sure to check the journal with micrometers if the flattened plastic indicates more than 0.001″ difference.***

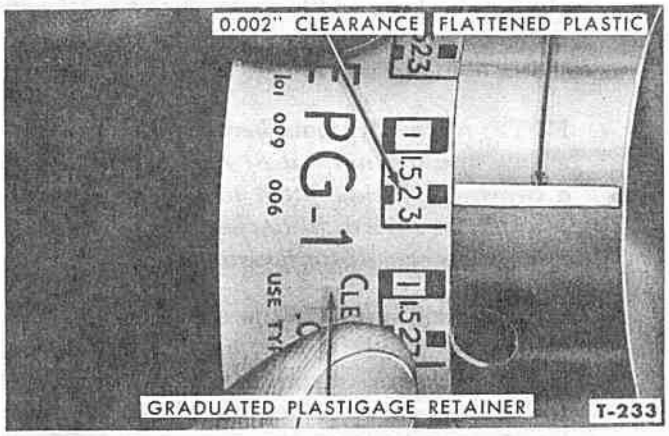


Figure 57—Measuring Flattened Plastigage

6. Remove the jack from under the crankshaft after the bearings have been selected.

D. Installation

1. Lubricate the bearing insert with engine oil.
2. With the bearing insert installation tool in the crankshaft at the manifold side of engine, hold the bearing in place on the crankshaft with the plain end of the bearing at the locking tang side of the cylinder block. Turn the crankshaft clockwise until the bearing is seated in the block.

   NOTE: ***Pressure may have to be applied on the bearing insert to prevent the installation tool from slipping under it.***

3. Install the lower half of the bearing insert in the bearing cap and lubricate the bearing with engine oil. Hold the bearing cap in place with the locking tang toward the camshaft side of the engine and install the two bolts and washers. Tighten the bolts to 95-105 ft. lbs. torque.

BALANCER

Starting with Serial No. 102357 on 172 cu. in. diesel engines, a balancer is provided to dampen out engine vibration. The balancer is attached to the cylinder block by special bolts and is driven by a drive gear provided on the crankshaft, see Figure 58.

A. Removal

1. Remove the oil pan and oil pump. Remove the remaining bolt that attaches the baffle to the balancer and remove the baffle.
2. Remove the hollow bolt, hex bolt and special retainers that attach the balancer to the cylinder block and remove the balancer.

B. Inspection

1. Check the counterweight gears for wear, cracks or looseness on the pivot shafts.
2. Check the gear housing for cracks.
3. Check the needle bearings for roughness or wear by rotating the gears.
4. Replace the balancer if any of these conditions are evident.

C. Installation

1. Make sure that the mounting surfaces on the cylinder block and balancer are clean. Rotate the crankshaft until the timing mark on the flywheel and No. 1 cylinder are at TDC (top dead center). Rotate the counterweight gears to align the balance mark on the counterweight drive gear with the mark on the crankshaft gear as shown in Figure 59.

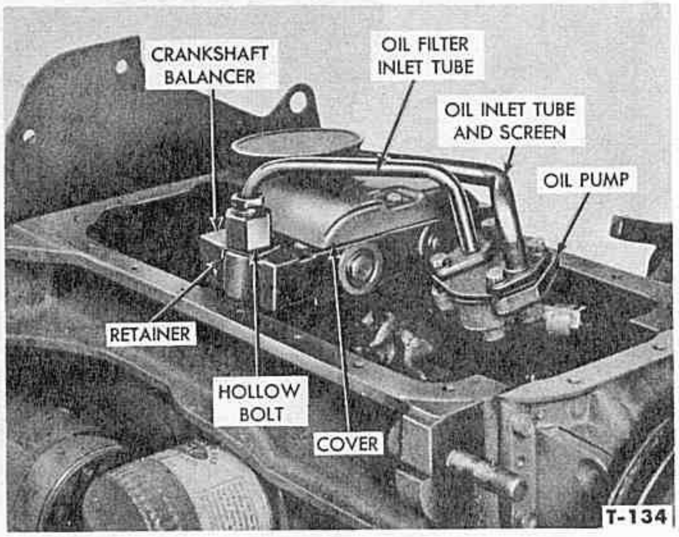


Figure 58—Balancer Installed

2. With the balance marks aligned, place the balancer in position on the cylinder block. Install the two retaining bolts. Tighten the larger bolt to 70-80 ft. lbs. torque and the smaller bolt to 60-70 ft. lbs. torque.
3. Install a dial indicator on the cylinder block with the button contacting the balancer drive gear. Set the dial at zero then check the backlash between the crankshaft gear and balancer drive gear. The backlash should be 0.005"-0.012".
4. After obtaining the specified backlash, install the two special retainers and retaining bolts then tighten them to the specified torque. Bend the tabs on the retainers to lock the bolts in place. Install the baffle and tighten the attaching bolts to 6-9 ft. lbs. torque.

   NOTE: ***The baffle attaching bolts should not be tightened until the oil pump inlet tube and screen has been installed.***

5. Install the oil pump and oil pan. Fill the crankcase to the proper level with the recommended oil. Start the engine and check for leaks.

FLYWHEEL

There are several different flywheels used on Ford Tractor engines. The flywheels differ in size; however, the basic function of the flywheels is the same. The weight of the flywheel is used to eliminate engine roughness while the rear face is used as a friction surface for the clutch. A ring gear is mounted on the flywheel to provide a means of starting the engine. The flywheel mounts on a shoulder at the rear of the crank-

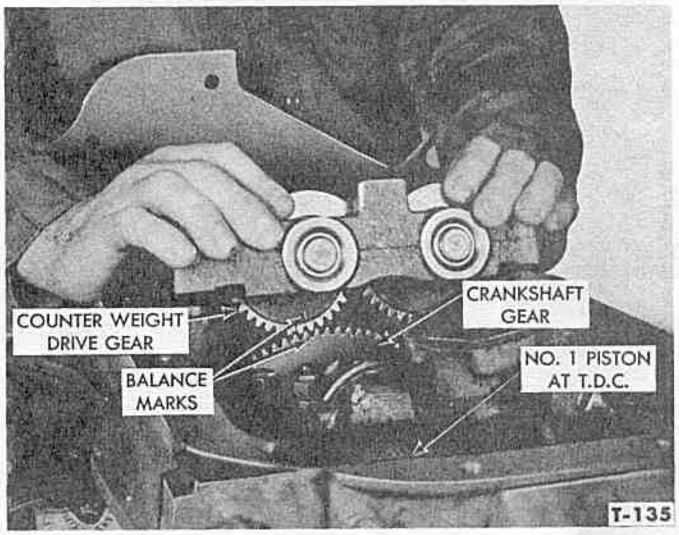


Figure 59—Installing Crankshaft Balancer

shaft and is retained by six bolts. The mounting holes are unevenly spaced so that it can be mounted in only one position.

A. Removal

1. Split the tractor between the engine and transmission or remove the engine.
2. Remove the (clutch housing Select-O-Speed) pressure plate and clutch disc from the engine.
3. Before removing the flywheel attaching bolts, check the runout with a dial indicator, see Figure 60. Remove the six flywheel attaching bolts. Tap the flywheel with a soft mallet or hammer to loosen it on the crankshaft. Lift the flywheel from the crankshaft.

   CAUTION: *Grasp the flywheel firmly while tapping it with a hammer to prevent dropping it and causing personal injury.*

B. Inspection

1. Replace the flywheel if the runout exceeds 0.008″. Inspect the friction surfaces of the flywheel and the clutch pressure plate for score marks, check marks and for evidence of overheating.
2. Replace the ring gear if loose on the flywheel or if the teeth are worn or broken.
3. Replace the clutch pilot bearing if the bearing feels rough when rotated.

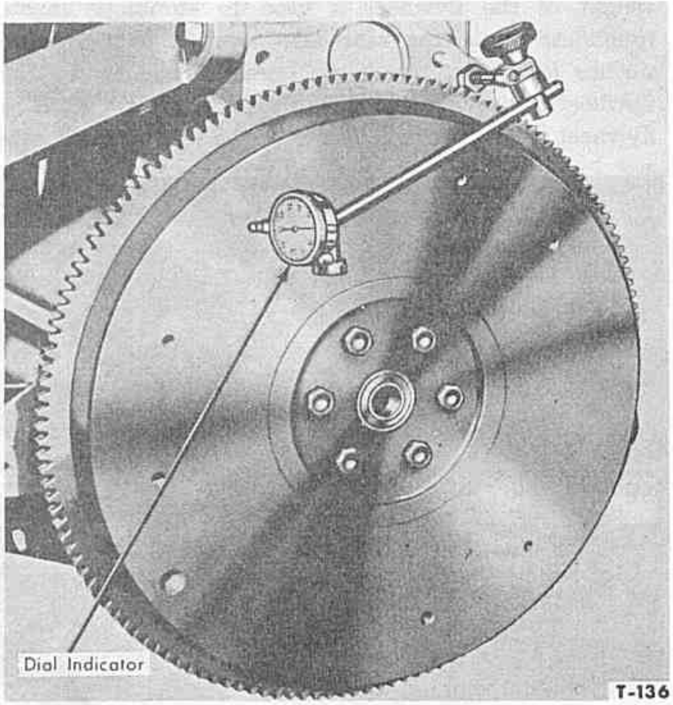


Figure 60—Checking Flywheel Runout

C. Repair

Flywheel Ring Gear Replacement :

1. Drill a ¼″ hole nearly through the ring gear. Do not drill into the flywheel. Split the gear with a chisel. Wipe the replacement gear and flywheel mating surfaces clean before installing the new gear.
2. Expand the gear by uniformly heating it to approximately 360° (gear will appear to change from a light to a dark straw color at this temperature) then quickly transfer it to the flywheel and allow it to cool.

   IMPORTANT: *Do not overheat the gear more than 360° as softening will result.*
3. Check the gear runout after the flywheel is installed on the crankshaft. The runout must not exceed 0.008″.

Clutch Pilot Bearing Replacement :

1. Drive the bearing out of the flywheel with Clutch Pilot Bearing Replacer 7600-C. The bearing can be removed with bearing remover 7600-E if the flywheel is installed, see Figure 61.
2. Install the bearing with Clutch Pilot Bearing Replaced 7600-C, see Figure 62.

D. Installation

1. Clean both mating surfaces before installing the flywheel.
2. Check the runout of the crankshaft flange with an indicator before installing the flywheel. Runout must not exceed 0.001″.

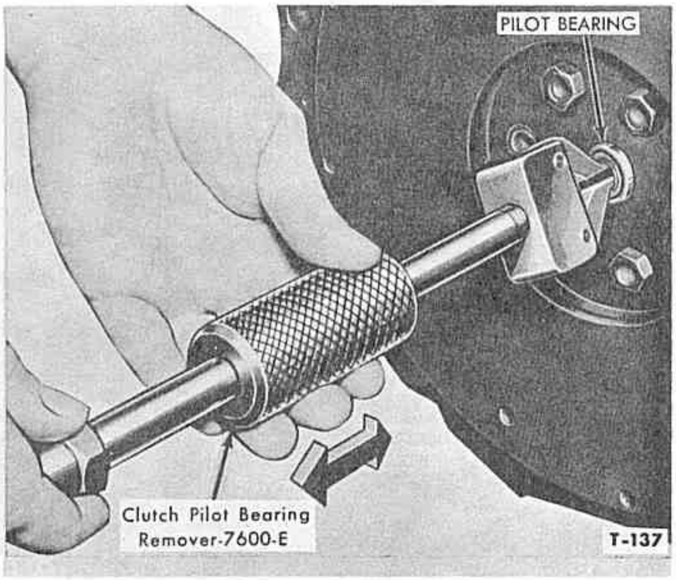


Figure 61—Removing Clutch Pilot Bearing

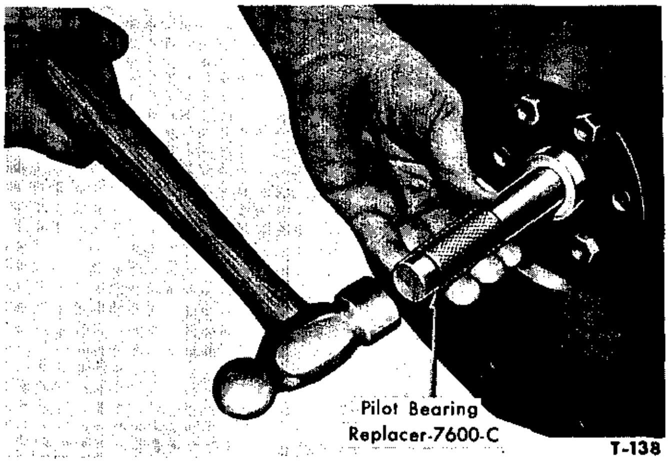


Figure 62—Installing Clutch Pilot Bearing

3. Place the flywheel in position on the crankshaft, install the cap screws and tighten them to 75-85 ft. lbs. torque.
4. After installation, check the runout. If the runout exceeds 0.008" total indicator reading, the flywheel should be replaced.
5. Install the engine or connect the transmission to the engine.

CRANKSHAFT

A. Removal

1. Remove the engine from the tractor and place it in an engine stand.
2. Remove the oil pan, oil pump, flywheel and rear cover plate. Remove the crank ratchet or bolt, washer and pulley.
3. Remove the bolts that attach the governor housing to the cylinder front cover and remove the housing and lever.

   NOTE: ***Engines up through 1956 have a governor housing. After 1956 the governor housing is an integral part of the cylinder front cover.***
4. Remove the bolts that attach the cylinder front cover to the cylinder block and remove the cover. Slide the governor off the crankshaft (gasoline and LP-Gas engines only). Remove the balancer from the cylinder block if so equipped.
5. Remove the connecting rod bearing caps and, if they are not numbered, mark them so that they can be reinstalled on the same rod assembly. Remove the main bearing caps and the crankshaft. Reinstall the bearing caps on the cylinder block for safe keeping, after the shaft is removed. Remove the rear main bearing seal from the cylinder block.

B. Inspection

1. Clean the crankshaft in a tank of solvent. Clean all drilled passages with a rifle brush then blow out the passages with compressed air.
2. Place the crankshaft on "V" blocks to check the runout at the center journal with a dial indicator. Replace the shaft if the runout exceeds 0.003". Replace the crankshaft gear if worn or chipped.
3. Measure each journal at a minimum of four places to determine the wear, out of round and taper. If the out of round is in excess of 0.0005" and the taper is more than 0.001" or the wear is more than 0.002", regrind the shaft for the next undersize bearings or replace the shaft.

   Main and connecting rod bearings are available in 0.001", 0.002", 0.010" and 0.020" undersize. New crankshaft dimensions are as follows:

Main Journal Diameter	2.4974"–2.4988" —134 and 172 Cu. In. Gasoline or LP-Gas engines
	2-4969"–2.4977" —144 and 172 Cu. In. Diesel engines.
Connecting Rod Journal Diameter	2.2988"–2.2978" —134 and 172 Cu. In. Gasoline or LP-Gas engines and 144 and 172 Cu. In. Diesel engines.

C. Repair

1. Remove the crankshaft gear with Remover 6306-AE as shown in Figure 63.
2. Replace the gear with Installer 6306-AF as shown in Figure 64.

D. Installation

1. Clean the main bearing bores and oil seal groove thoroughly before installing the bearings in the block. Soak the main bearing oil seals in engine oil at least for ½ hour before installation. Work the seals into the rear main bearing cap and cylinder block, then seat them with forming Tool 6701-A and hammer. Cut the edges flush as shown in Figure 65.
2. Install the main bearings in the cylinder block and bearing caps. Lubricate them with engine

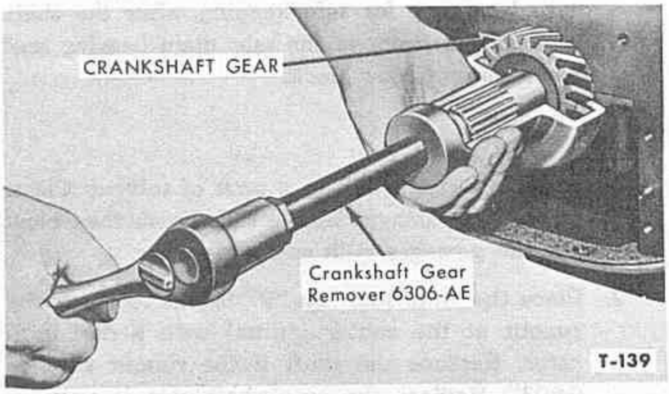


Figure 63—Removing Crankshaft Gear

oil. Turn the crankshaft to position the timing mark on the camshaft gear at the bottom. Align the timing mark on the crankshaft gear with the one on the camshaft gear, then lower the crankshaft into the cylinder block. Check the bearing clearance with Plastigage.

3. Install the main bearing caps and tighten the bolts to 95-105 ft. lbs. torque (gasoline and LP-Gas engines) or to 110-115 ft. lbs. torque (diesel engines).

4. Dip each rear main bearing cap vertical seal in engine oil and immediately slide it into place as shown in Figure 66. Tap the seal until it is firmly in place. The ends of the vertical seals should extend approximately $\frac{3}{64}''$ beyond the surface to provide a good seal.

   IMPORTANT: ***Never apply oil to the vertical seals until it is time to install them, since a swelling action takes place immediately after oil is applied.***

5. Check the connecting rod bearing to crankshaft clearance with Plastigage then install and tighten the connecting rod nuts to 45-50 ft. lbs. torque. Install and tighten new pal nuts to 3-4 ft. lbs. torque.

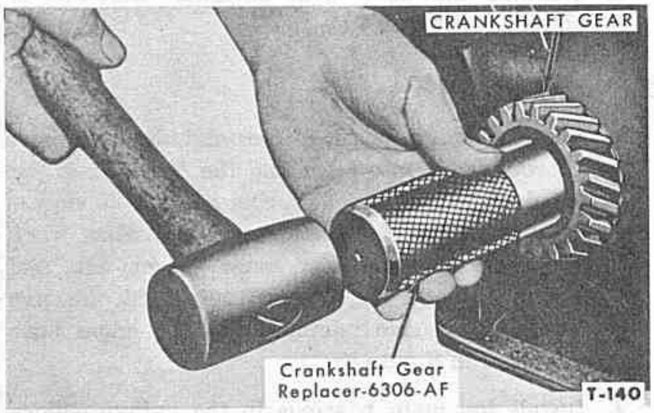


Figure 64—Installing Crankshaft Gear

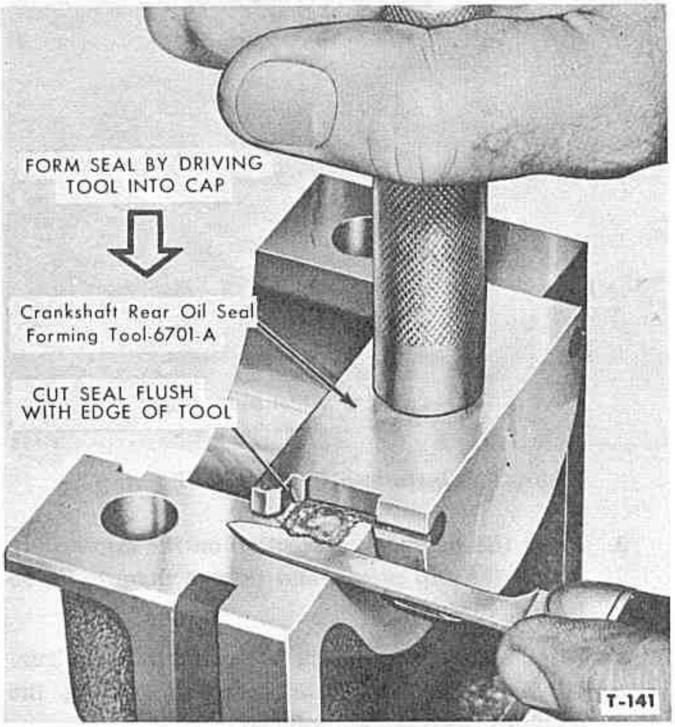

FORM SEAL BY DRIVING TOOL INTO CAP
Crankshaft Rear Oil Seal Forming Tool-6701-A
CUT SEAL FLUSH WITH EDGE OF TOOL
T-141

Figure 65—Installing Rear Main Bearing Cap Oil Seal

6. Install the cylinder rear cover plate and flywheel. Install the governor (gasoline and LP-Gas engines only). Install the cylinder front cover and new gasket. If working on a 1956 engine or older, install the governor housing and lever.

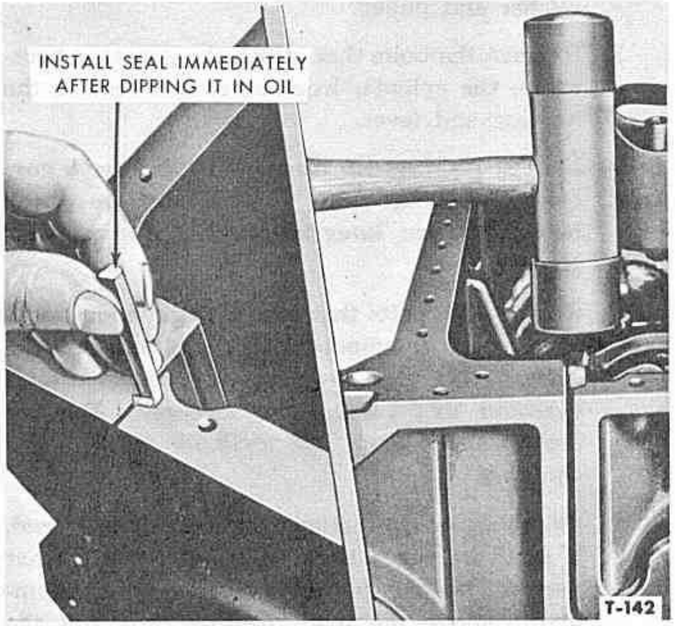


Figure 66—Installing Bearing Cap Vertical Seals

7. Install the crankshaft pulley and secure with a flat washer, bolt or ratchet nut. Install the balancer if so equipped. Install the oil pump and oil pan. Install the engine in the tractor.

8. Fill the crankcase to the proper level with the recommended lubricant and the radiator with coolant. Start the engine and check for leaks.

7. ENGINE GOVERNOR AND TIMING GEAR COVER

Two different governors are used on gasoline and LP-Gas engines. Both are centrifugal, variable speed control type and are mounted on the front of the crankshaft directly behind the pulley, Figure 67. Early type governors are provided with a tab on the sleeve and driver assembly to engage the crankshaft and drive the governor. The later type governors are compressed between the pulley hub and crankshaft gear to provide a means of driving them. Moving the hand throttle lever to increase the engine speed applies pressure on the governor rod compensating spring. This actuates the governor arm, which in turn through linkage, opens the carburetor throttle valve.

Governor action is controlled by six steel balls (early type) or two rollers (late type), Figure 67. As engine speed increases, centrifugal force moves the balls or rollers outward. This action forces the upper race forward, moving the fork and governor arm against the governor compensating spring tension. This action tends to close the carburetor throttle until a balance between spring tension and governor action causes the engine speed to remain constant. Maximum engine speed is controlled by the adjustable stop on the throttle rod as shown in Figure 69.

A. Governor Removal

1. Drain the radiator and remove the upper and the lower hose.
2. On row crop tractors it is necessary to loosen the pedestal attaching bolts to move it forward approximately ¼-⅜ inch to provide clearance for the governor housing or cylinder front cover.
3. On industrial tractors, disconnect the power steering pump from the engine and lay it to one side.

NOTE: ***It is not necessary to disconnect the hydraulic lines.***

4. On industrial tractors, disconnect the drive hub

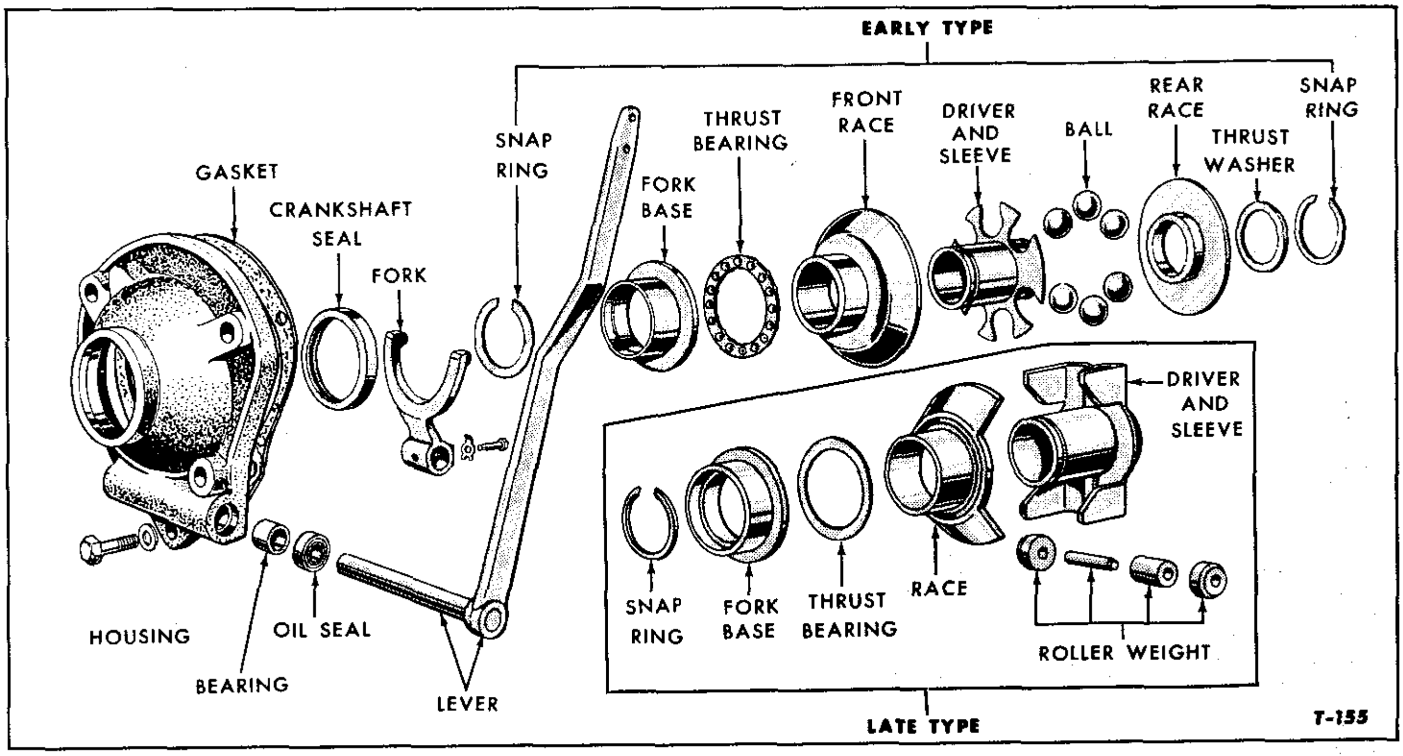


Figure 67—Governor Disassembled

from the front pulley and remove the drive hub and universal shaft.

5. Remove the fan belt, crank ratchet nut or bolt, and remove the front pulley and hub.
6. Disconnect the governor linkage from the governor arm.
7. If the engine is equipped with a governor housing, remove the housing from the cylinder front cover. Slip the governor off the crankshaft. If the governor housing is integral with the cylinder front cover, remove the cover then remove the governor. Clean all gasket surfaces thoroughly.

B. Disassembly

1. Remove the snap ring from the front end of the governor.
2. Lift the governor fork base, thrust bearing, race assembly and roller weights or balls as shown in Figure 67.
3. If disassembling a ball type (early type) governor, remove the rear snap ring and remove the thrust washer and case assembly from the driver and sleeve assembly.
4. Refer to Inspection, Paragraph C, below, then remove the fork retaining screw and slip the lever and shaft assembly from the housing.
5. Drive the needle bearings and seal from the governor housing or cylinder front cover with Remover and Replacer—18182, Figure 68.
6. Remove the crankshaft oil seal from the housing or cover with a bushing driver.

C. Inspection

1. Check the shaft for excessive clearance in the bearings. If excessive clearance is evident, replace the bearings and/or shaft.
2. Replace the races if there is evidence of scoring, pitting or wear.
3. Replace the thrust bearing if any of the bearings are missing or if the retainer is damaged.
4. Replace the sleeve and driver assembly if worn or damaged. Replace the steel balls or roller weights if worn or damaged.
5. Replace a governor housing or cylinder front cover that is cracked or damaged. Machined surfaces should be smoothed with a fine stone if nicked or burred.

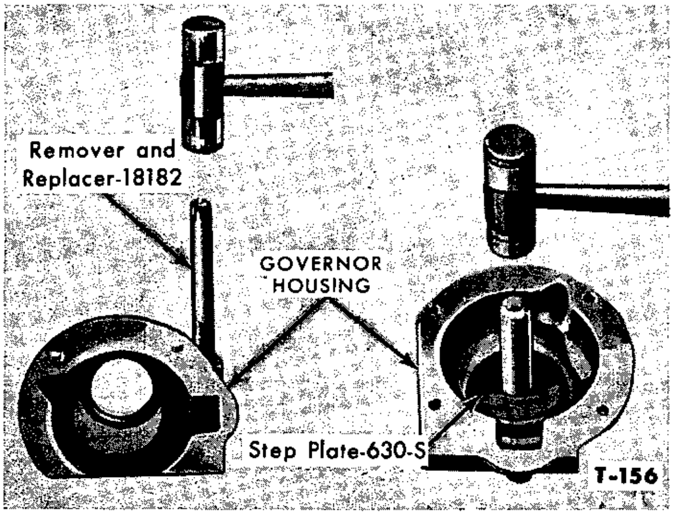


Figure 68—Removing or Installing Needle Bearings and Installing Crankshaft Oil Seal

D. Assembly

1. If assembling a ball type (early type) governor, install the bearing lower race, thrust washer and snap ring on the rear of the sleeve and driver assembly, Figure 67.
2. Position the ball or roller weights in the sleeve and driver assembly then install the bearing race.
3. Position the thrust bearing and governor fork base on the race, then install the snap ring.
4. Install the two needle bearings in the governor housing or cylinder front cover with Remover and Replacer—18182, if they were removed.
5. Install a new crankshaft oil seal with the correct Step Plate from Tool Set FT-48.
6. Install the lever shaft oil seal in the left side of the governor housing or cover.
7. Slide the shaft into the housing or cover far enough to start the fork on the shaft, then slide the shaft the rest of the way in. Install the fork retaining screw and lock washer.
8. Install a new plug in the housing or cover. Make sure that the lever operates freely.

E. Installation

1. Apply a light film of grease on the gasket surface and position a new gasket on the cylinder block or front cover.
2. Slip the governor into place on the crankshaft.
3. Install the cylinder front cover or governor housing. Tighten the attaching bolts to 10-15 ft. lbs. torque.
4. Connect the governor linkage to the governor arm.
5. Install the front pulley and hub. Install the fan belt.
6. If working on an industrial tractor, install the universal shaft and drive hub.
7. Install the power steering pump and adjust the belt tension.

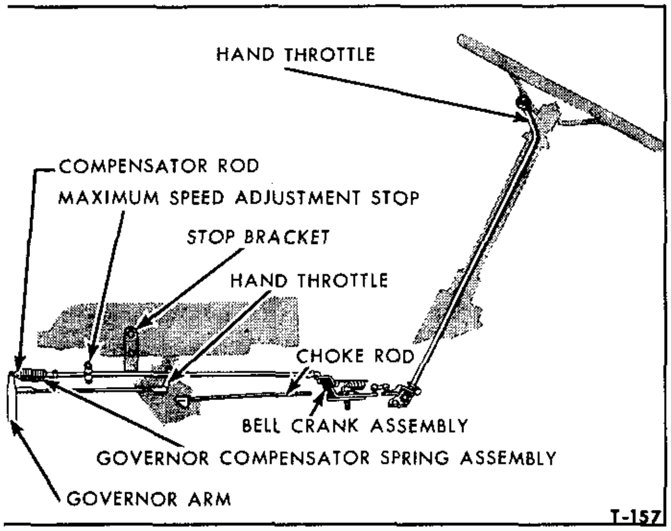


Figure 69—Governor and Control Linkage Adjustments

8. *If working on a row crop tractor, move the pedestal into place and tighten the attaching bolts.*
9. Install the radiator upper and the lower hose.
10. Fill the radiator with coolant and check for leaks.
11. Adjust the governor linkage as detailed below.

F. Setting Governed Engine Speed

1. Before attempting to set the engine governed speed, make certain that the governor and carburetor throttle lever are in the full open position. This can be checked by disconnecting the throttle rod at the carburetor and moving the hand throttle lever to the full open position. If the throttle rod cannot be connected to the carburetor without moving the governor lever, the linkage must be adjusted.
2. To adjust the linkage, loosen the locknut at the carburetor rod clevis, as shown in Figure 69. With the hand throttle and carburetor lever in full open position, lengthen or shorten the rod as necessary to connect it to the throttle lever. Tighten the lock nut.
3. With the engine at normal operating temperature, set the idle speed to 450-475 rpm.
4. At this rpm, the governor arm should be contacting the end of the compensator rod with a minimum of spring tension. Adjust the compensator spring as required.
5. With the engine running under no load, open the hand throttle to the wide open position. If the engine rpm registers 2200 rpm on Series 501 through 701 tractors or 2400 rpm on Series 800 through 901 tractors, the governor is properly set. To adjust the linkage for the recommended speed, loosen the lock nut on the maximum speed adjustment stop, Figure 69. Start the engine and set the hand throttle until the Proof-Meter registers the correct rpm for the model being checked, then slide the maximum speed adjustment stop against the stop bracket on the cylinder block. Tighten the maximum speed adjustment stop lock nut.
6. If the throttle has a tendency to creep, remove the cotter pin from the castellated nut on the bellcrank, Figure 69. Tighten the nut as required to increase the spring tension. Install the cotter pin.

8. CAMSHAFT AND CAMSHAFT GEAR

The camshaft cannot be removed with the engine in the tractor. If the front of the camshaft is provided with a tapped hole, as they were on earlier models, it is possible to remove the camshaft gear after the cylinder front cover and governor have been removed.

Later model engines are provided with a snap ring instead of a bolt to retain the gear after it has been pressed on the shaft. The procedure for camshaft gear replacement will be after the camshaft has been removed from the engine.

A. Camshaft Removal

1. Remove the engine from the tractor and mount it in an engine stand.
2. Remove the cylinder front cover, governor or sleeve and slinger on diesel engines.
3. Remove the flywheel and engine rear plate.
4. Remove the hydraulic pump drive gear cover, gasket and the pump drive gear from the rear of the camshaft, Figure 70.

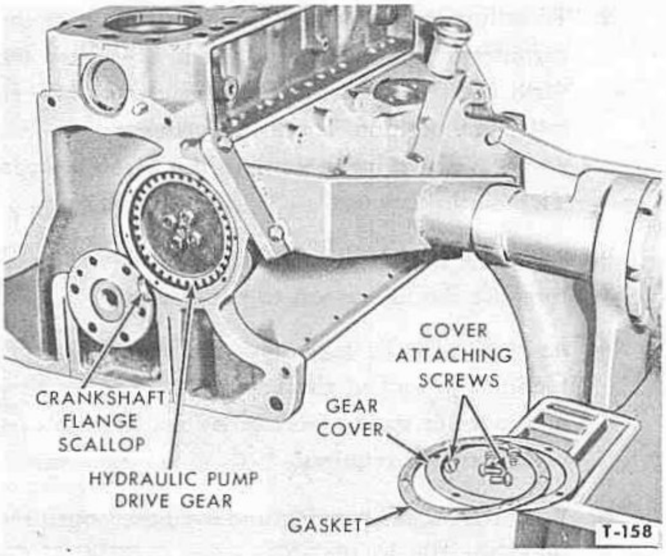


Figure 70—Hydraulic Pump Drive Gear and Related Parts

5. Remove the rocker arm cover. Loosen the tappet adjusting screws and carefully remove the push rods.
6. Invert the engine so that the tappets will fall away from the camshaft.
7. Pull the camshaft gear away from the cylinder block as far as possible. Check the clearance between the hub of the camshaft gear and the thrust plate with a feeler gauge, as shown in Figure 71. If the clearance exceeds 0.007″, replace the thrust plate before reassembly.

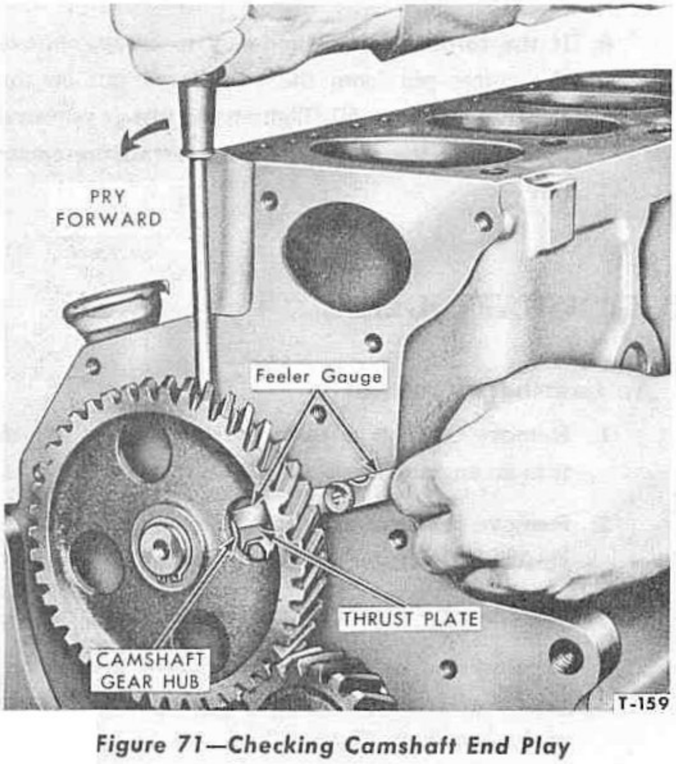


Figure 71—Checking Camshaft End Play

8. Remove the two cap screws that attach the thrust plate to the cylinder block, as shown in Figure 72.
9. Carefully withdraw the camshaft from the cylinder block, being careful that the sharp edges of the cam lobes do not damage the cam bearing bores.
10. Remove the snap ring or bolt and washer from the front of the camshaft. Carefully press the camshaft out of the gear. Remove the Woodruff key from the camshaft.

B. Inspection

1. Visually inspect the camshaft journals and lobes for roughness, scores, nicks, pits or discoloration from heat. Inspect the distributor or fuel injection pump drive gear for worn or broken teeth. Replace the camshaft if any of these defects are evident.
2. Measure the diameter of the bearing journals and replace the shaft if less than 1.9245″ or if

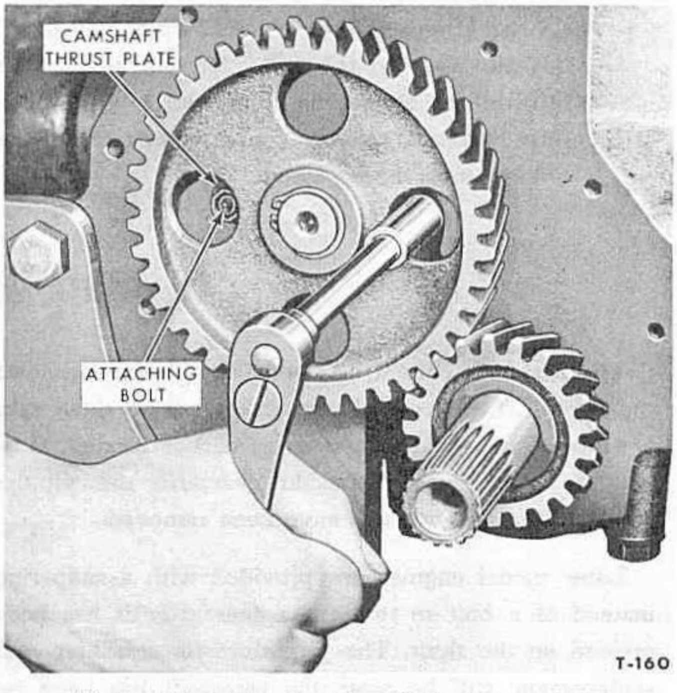


Figure 72—Removing Camshaft Thrust Plate Attaching Screws

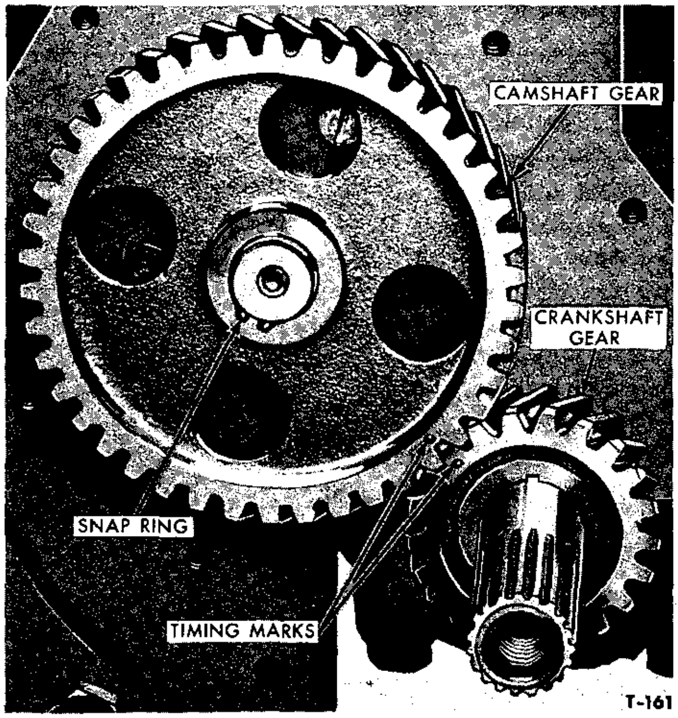


Figure 73—Valve Timing Marks

out of round more than 0.001". The camshaft bearing bore in the cylinder block is 1.9275-1.9285 inches. If the clearance between the camshaft and cylinder block exceeds 0.005", replace the part at fault.

3. Replace the camshaft gear or hydraulic pump drive gear, if wear or damage is evident.

C. Installation

1. Install the Woodruff key in the front of the camshaft. Position the camshaft thrust plate in place, then carefully press the gear onto the camshaft with the timing mark on the gear facing upward. Install the snap ring or bolt and washer. Tighten the bolt to 35-45 ft. lbs. torque.
2. Carefully install the camshaft in the cylinder block being careful not to damage the bearing bores with the sharp edges of the cam lobes. Make certain that the timing mark on the camshaft gear is aligned with the timing mark on the crankshaft gear, Figure 73. Install and tighten the camshaft thrust plate attaching screws to to 12-16 ft. lbs. torque.
3. Check the camshaft end play with a feeler gauge to be certain that it is within tolerances (0.003-0.007"), Figure 71.
4. Position the hydraulic pump drive gear on the rear of the camshaft and secure with four cap screws and lock washers. Tighten the cap screws to 12-16 ft. lbs. torque.
5. Coat the mating surfaces of the hydraulic pump gear cover and cylinder block with sealer. Position a new gasket on the cover then install the cover on the block. Tighten the screws to 12-16 ft. lbs. torque.
6. Invert the engine to allow the tappets to fall into place. Install the push rods and adjust the tappets.
7. Install the governor (gasoline engine only) or sleeve and oil slinger (diesel engine only). Install the cylinder front cover, pulley and fan belt.
8. Install the engine in the tractor. Fill the crankcase to the proper level with the recommended oil. Fill the radiator with coolant.
9. Start the engine and check for leaks. After the engine has reached normal operating temperature, set the tappets to 0.014-0.016 inches.

9. ENGINE TUNE-UP

A tune-up is a systematic procedure for testing various engine components, and, if necessary, bring them within recommended specifications to restore engine efficiency and performance.

The tune-up schedule (Table 1) is applicable for either a minor or major tune-up. A minor tune-up is recommended each 600 hours and a major tune-up is recommended each 1200 hours.

Diesel fuel injectors should be cleaned and set after every 400 hours of operation.

Table 1—Tune-Up Schedule

Operation	Perform on	
	Minor	Major
SPARK PLUGS* Clean, Adjust & Test or replace	X	X
ENGINE COMPRESSION Take compression reading of each cylinder		X
INTAKE MANIFOLD Check & Tighten Bolts		X
DRIVE BELTS Check and Adjust the tension of all drive belts	X	X
BATTERY Clean battery cables and terminals	X	X
Tighten Cable clamps	X	X
Grease Battery Terminals	X	X
Check battery state of charge	X	X
ELECTRICAL Oil generator rear bearing through oil cup	X	X
Check generator output		X
Check starter motor current draw		X
Check coil output*		X
Perform a primary circuit resistance test*		X
Perform a secondary circuit continuity test*		X
DISTRIBUTOR* Check the condition of the breaker points	X	X
Replace the breaker points and the condenser		X
Check and adjust the breaker arm spring tension		X
Lubricate the distributor cam. Lubricate the distributor bushing through the oil cup	X	X
Check and adjust point gap	X	X
DISTRIBUTOR* Check and adjust centrifugal advance Clean distributor cap and rotor	X	X
FUEL SYSTEM Drain fuel system filter	X	
Drain fuel system filter element**	X ■	
Clean carburetor fuel bowl and adjust float setting*		X
Clean and adjust fuel injectors**	▲	
ADJUSTMENTS Check and adjust ignition timing*	X	X
Check and adjust engine idle speed	X	X
Adjust idle fuel mixture*	X	X
Check and adjust valve lash		X
Check and adjust governor speed*	X	X

*Gasoline & LP-Gas Engines Only.
**Diesel Engines Only.
■Every 200 Hours.
▲Every 400 Hours.

MANIFOLD VACUUM

A. Test Procedure

A manifold vacuum test aids in determining the condition of an engine and also in helping to locate the cause of poor engine performance. To test manifold vacuum:

1. Operate the engine for a minimum of ½ hour at 1200 rpm.
2. Connect an accurate, sensitive vacuum gauge to the intake manifold.
3. Operate the engine at recommended idle rpm.
4. Check the vacuum reading on the gauge.

B. Test Conclusions

1. Manifold vacuum is affected by carburetor adjustment, valve timing, the condition of the valves, cylinder compression, and leakage of the intake manifold, carburetor (gasoline or LP-Gas engine only), or cylinder head gasket.
2. Because abnormal gauge readings may indicate that more than one of the above factors are at fault, exercise caution in analyzing an abnormal reading. For example, if the vacuum is low, the correction of one item may increase the vacuum enough to indicate that the trouble has been corrected. It is important, therefore, that each cause of an abnormal reading be investigated and further tests conducted where necessary to arrive at the correct diagnosis of the trouble.
3. Table 2 lists various types of readings and their possible causes.
4. Allowances should be made for the effect of altitude on the gauge reading. The engine vacuum will decrease with an increase in altitude.

ENGINE COMPRESSION

A. Test Procedure

Gasoline or L.P. Gas Engine:

1. Be sure the battery is up to specifications. Operate the engine for a minimum of ½ hour at 1200 rpm. Stop the engine, then remove all the spark plugs.
2. Set the throttle plate and choke plate in the wide open position.
3. Install Compression Gauge UTC-48 in No. 1 cylinder.
4. Crank the engine several times and record the highest reading obtained. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat the test on each cylinder, cranking the engine the approximate same number of times for each cylinder as was required to obtain the highest reading on No. 1 cylinder.

Diesel Engine:

1. Be sure the battery is up to specifications. Operate the engine for a minimum of ½ hour at 1200 rpm, then stop the engine.
2. Remove the injector and seat washer from No. 1 cylinder.
3. Clean the injector bore and crank the engine to blow out any loose carbon particles.
4. Install the Gauge Adapter (5) from Compression Gauge Kit N-1000-BB in an injector bore using a new seat washer and the injector mounting bolts.
5. Connect the Pressure Gauge and hose to the adapter.
6. Start the engine and accelerate to 1400 rpm and observe gauge reading which should be approximately 490 psi.
7. Readings which are either 20 pounds over or 20 pounds below normal cylinder pressure would indicate the same cylinder, rings, and valve problems as described in paragraph B.
8. Check each cylinder in turn in the same manner as described for No. 1 cylinder.

B. Test Conclusion

1. A variation of ± 10 pounds from specified pressure is satisfactory. However, the compression of all cylinders should be uniform within 10 pounds. A reading of more than the allowable tolerance below normal indicates leakage at the cylinder head gasket, piston rings or valves.
2. A reading of 10 pounds over normal indicates excessive carbon deposits on the piston and cylinder head.
3. A low even compression in two adjacent cylinders indicates a cylinder head gasket leak. This should be checked before condemning the rings or valves.

To determine whether the rings or the valves are at fault, squirt the equivalent of a tablespoon of heavy oil into the combustion chamber, then crank the engine to distribute the oil and repeat the compression test. The oil will temporarily seal leakage past the rings. If approximately the same reading is obtained, the rings are satisfactory, but the valves are leaking. If the compression has increased 10 pounds or more over the original reading, there is leakage past the rings. During a compression test, if the pressure fails to climb steadily and remains the same during the first two successive strokes, but climbs higher on the succeeding strokes, or fails to climb during the entire test, it indicates a sticking valve.

Table 2—Manifold Vacuum Gauge Readings

Gauge Reading (Inches High)	Engine Condition
19-20	Normal
Low and steady.	Loss of power in all cylinders caused possibly by late ignition, fuel injector pump timing, valve timing or loss of compression.
Very low.	Manifold, carburetor, or cylinder head gasket leak.
Needle fluctuates steadily as speed increases.	A partial or complete loss of power in one or more cylinders caused by: a leaking valve; cylinder head or intake manifold gasket leak; a defect in the ignition system; fuel injector; or a weak valve spring.
19-20	Normal
Gradual drop in reading at engine idle.	Excessive back pressure in the exhaust system.
Intermittent fluctuation.	An occasional loss of power possibly caused by a defect in the ignition system, fuel system (diesel) or a sticking valve.
Slow fluctuation or drifting of the needle.	Improper idle mixture adjustment, carburetor or intake manifold gasket leak, or possibly late valve timing.

10. TROUBLE SHOOTING

Poor engine performance can be attributed to the engine itself or to forces on the vehicle that tend to retard its motion. Dragging brakes, for example, cause the engine to work harder and poor engine performance results.

Engine performance depends on proper fuel distribution, correctly timed ignition, or fuel injection pump, normal uniform compression, normal operating temperature, properly regulated flow of fuel air mixture to the cylinders, and the unobstructed flow of exhaust gases.

Engine trouble symptoms are discussed here with instructions on what to do to satisfy the above conditions and regain good engine performance.

GASOLINE AND LP-GAS ENGINES

A. Engine Does Not Develop Full Power

If the engine does not develop full power, has a low top speed, or faulty acceleration, it may be advisable to perform a complete engine tune-up. However, if the tune-up was already performed, and did not correct the trouble, or if the complaint is received on a fairly new engine, proceed as follows eliminating any factors that are known to be correct. Refer to the trouble shooting road map in Figure 74 for the sequence of tests and corrections.

Before starting with the actual trouble shooting procedure, check the condition of the air cleaner and be sure it is not clogged with dirt or debris. Check the governor setting and be sure the linkage is operating properly.

1. Remove one spark plug wire from a plug. Hold the terminal of the wire $\frac{3}{16}''$ away from the cylinder head. If a hot spark jumps this gap regularly at engine idle and at higher engine speeds, the ignition can be considered satisfactory as far as the voltage is concerned. Check the ignition timing, with the aid of a timing light, and correct the timing if necessary. If a weak spark is indicated, check the coil secondary wire and the spark plug wires to make sure that they are seated firmly in their sockets. If a weak spark is indicated at all wires, proceed with the ignition trouble shooting procedure that applies, to locate the fault in the ignition system.
2. Test the compression of each cylinder. If the pressure is above normal by more than 10 lbs., excessive deposits of lead or carbon are indicated. Clean carbon or lead from the combustion chambers.

   If the pressure is below normal, by more than 10 lbs., excessive clearance between rings and cylinder walls is indicated, or the valves are not seating properly. To determine whether valves or rings are causing trouble, squirt a small quantity of engine oil into cylinder and recheck the compression. If the compression is now normal, the rings or cylinder walls are at fault. Install new rings or rebore the cylinders. If the compression is still low, the valves are not seating properly. Grind the valves.
3. If the compression shows normal at the compression test, check the valve adjustment. If the valve lash is not correct, make a valve adjustment and test drive the tractor. If the valve lash is correct when checked, proceed with checking the carburetor adjustment.
4. If the carburetor is out of adjustment, correct the adjustment and then test. If adjustment was correct, disassemble and clean the carburetor

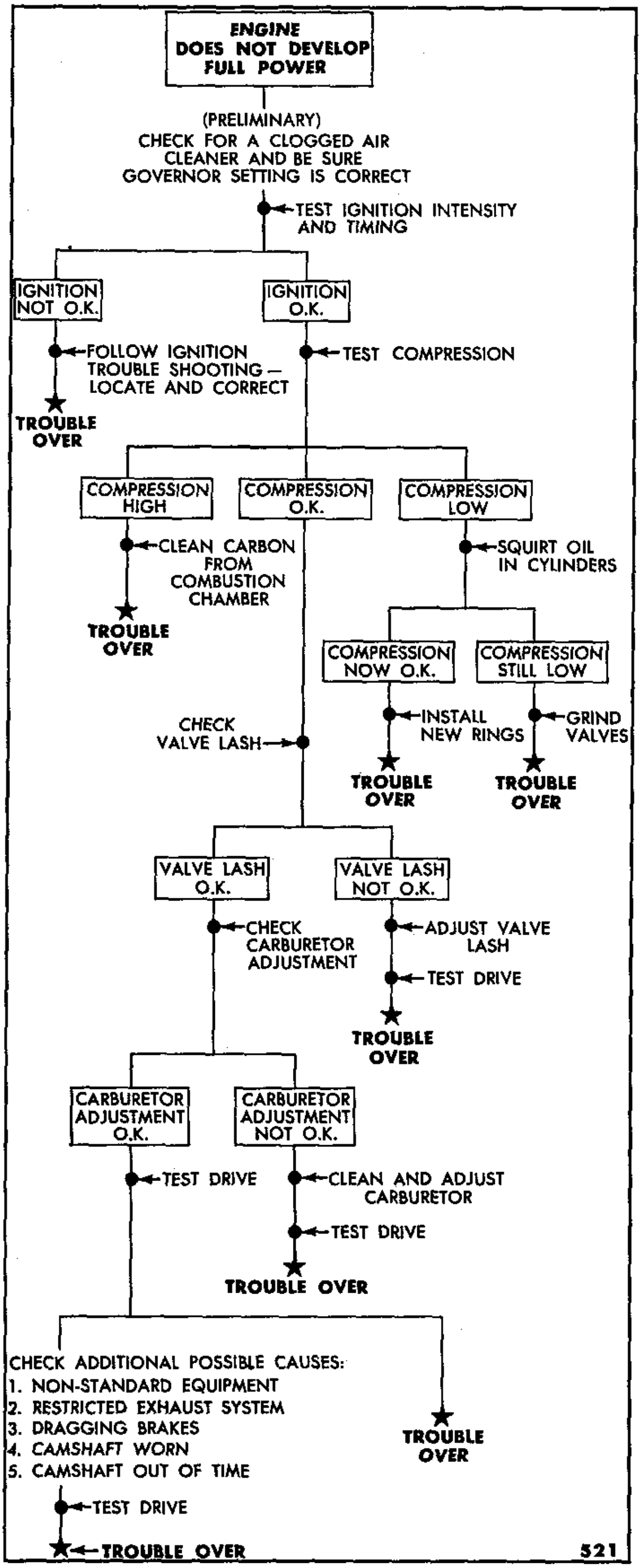


Figure 74—Engine Does Not Develop Full Power—Road Map

thoroughly, then assemble it and make the necessary preliminary adjustments. Perform a final adjustment with the carburetor on the tractor. If the carburetor adjustment is correct when checked, proceed with checking the additional possible causes shown in Figure 74.

B. Engine Runs Rough

Make sure the engine is thoroughly warmed up and the choke control is in all the way.

Determine whether the trouble occurs at idle or at a higher speed.

If the engine runs rough at idle and not at higher speeds, readjust the idle mixture until the engine runs smoothly. If the engine is still "rough," check plug fouling. If the engine runs rough at higher speeds, check the ignition, compression and valve action.

1. Check the spark at each spark plug wire. If the spark is intermittent at each wire, check the condition of the distributor breaker points. Replace badly pitted or burned points. If the spark is intermittent at only one wire, check for bad insulation on the spark plug wire or for a cracked distributor cap. Replace any units found defective. If the spark is OK at all wires, check for a faulty spark plug. Replace defective plugs.
2. If the compression of any cylinder is above normal by more than ten pounds, it will be necessary to remove the cylinder head and clean out the carbon or lead deposits from the combustion chamber.

   If the compression of any cylinder is below normal by 10 pounds or more, squirt oil in the cylinder and recheck compression. If compression is now normal, the piston, cylinder, or rings are defective. Repair or replace as required. If the compression is still low, the valves are sticking or are not seated properly. Check 3 below.
3. Remove the cylinder head (or valve chamber cover), and check for sticking valves (bent stem or "varnish" on stem or bent push rods). Free up the sticking valves if possible, or replace the valve or guide if necessary.
4. If the above procedures do not correct the troubles, check the valve timing. Retime the camshaft if necessary.

C. Engine Misfires Under Load

If the engine misfires under load, check the ignition.

1. Remove the distributor and follow the procedure given in the trouble shooting map in Figure 75.
   a. If distributor is faulty, make the necessary repairs.
   b. If coil is faulty, replace the coil.
   c. If the distributor and coil are in good working order, check the fuel system.

2. Check the fuel system for overall operation with a combustion analyzer.
   a. Make corrections to the carburetor or fuel lines as required.
   b. If all other conditions are satisfactory, misfiring under load may be caused by sticking valves. If the valves are sticking, free up the action.

D. Engine Starts But Fails to Keep Running

If the engine starts and stops after a short period of running and cannot again be started, the most probable cause is that fuel is not reaching the carburetor.

1. Clear the fuel line and test the gasoline for water.
2. In rare cases, the ignition coil or condenser will allow the engine to start but will fail to deliver a spark when hot. Turn the ignition switch ON. Crank the engine and test the spark intensity with a spark meter. If the spark will not jump a $3/16''$ gap, test the coil and condenser on a Distributor Test Set, when they are at operating temperature. Replace the faulty unit.

E. Engine Misfires and/or Backfires But Will Not Start

This symptom indicates that the spark plugs are not firing in their proper order, either due to the ignition high tension system being shorted, the spark plug wires being interchanged, or the camshaft being out of time. Perform the following steps in the order given:

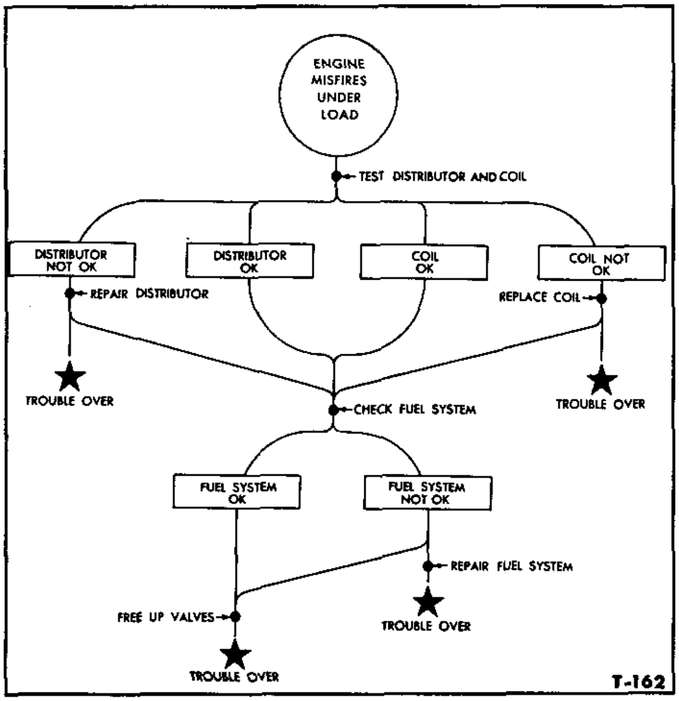


Figure 75—Engine Misfires Under Load—Road Map

1. Wipe all dust and moisture from the exterior of the distributor, coil, spark plugs, and spark plug wires and again attempt to start the engine.
2. If the engine still fails to start, make sure each spark plug wire is attached to the correct spark plug. Make sure the spark plug wires are installed in the correct terminals of the distributor cap, and check the interior of the distributor for dampness. Replace the distributor cap if there is evidence of shorting.
3. If the above procedure has not corrected the trouble, the camshaft is probably out of time. Remove the engine cylinder front cover and correct the valve timing.

F. Engine Cranks But Will Not Start

This trouble often is caused by temporary conditions which can be readily observed. Check for ignition shorts due to dampness and for vapor lock or flooded engine.

1. Turn the ignition switch ON, check the fuel supply, then use the procedure given below that fits the existing conditions:
   a. If engine is wet, wipe all moisture from the distributor, cap, coil, spark plugs, and spark plug wires.
   b. If the engine is hot, hold the hand throttle open and crank the engine. This clears away vapor lock which may be present.
   c. If the engine is flooded (due to repeated attempts to start while the carburetor was choked), push the choke button IN and open the hand throttle all the way. Crank the engine several revolutions to exhaust the surplus fuel.
   d. If the engine is extremely cold, make certain that the choke is working, then pull the choke button out to the stop. Hold the clutch pedal or inching pedal down and open the throttle lever part way. With the ignition switch ON, press the starter button.
   e. If engine cranks slowly, make sure the battery is fully charged and the viscosity of the engine oil is correct for the prevailing temperature. If the engine still fails to start, fuel is not being delivered to the engine, or the ignition system is faulty.
2. Determine if fuel is being delivered to the carburetor. Remove the drain plug from the carburetor float chamber. If fuel runs from the drain, it indicates fuel is being delivered to the carburetor. If no fuel is observed at the drain, fuel is not reaching the carburetor. Check the sediment bowl for water and clean out the fuel line.
3. Determine if current is being delivered to the spark plugs. Turn the ignition switch ON. Re-

move the wire from any spark plug, then hold the wire terminal $\frac{3}{16}''$ from the cylinder head while the engine is being cranked. If a spark does not jump this gap, the ignition is at fault. Follow the procedure under "Ignition System" for the symptom that applies in your case.

G. Engine Misfires On Acceleration or Hard Pull

The most probable cause for misfiring on acceleration or hard pull is the ignition or carburetor adjustment. Check the spark intensity at the spark plugs, and the fuel level in the carburetor float chamber.

1. Run the engine at idle speed. Remove the wire from No. 1 spark plug, hold it $\frac{3}{16}''$ from the cylinder head, and observe if the spark jumps regularly without missing. Make this test at each spark plug wire. If a satisfactory spark is obtained from each spark plug wire, proceed with steps 2 and 3 below.

   If an unsatisfactory spark or no spark is obtained at any of the wires, follow the procedure for the symptoms given under, "Ignition System" that most nearly applies.
2. Clean and gap plugs. Replace damaged or faulty plugs.
3. Check the carburetor power adjusting needle adjustment. If correctly adjusted, disassemble and clean the carburetor, then adjust the float level.
4. If performance is still below normal, test the compression of each cylinder and make corrections as required. Run the engine at idle speed and observe if any of the valves are noticeably noisy. Abnormally noisy valves indicate sluggish valve action. Make the necessary corrections.

DIESEL ENGINES

A. Engine Does Not Develop Full Power

Refer to the trouble shooting road map, Figure 76, and the following service checks which are suggested in the road map but may not appear elsewhere in this manual.

1. With the engine turned off and the fuel tank shut-off valve fully opened, disconnect the fuel line leading from the outlet side of the fuel filter. There should be a full volume of fuel flow from the filter outlet.

   Providing that the tank-to-filter line is not clogged, a restricted flow or no flow of fuel indicates either a clogged filter element or an air lock in the assembly. Bleed the assembly of air as described in the following step or replace the element as required.

   a. First, make sure that fuel is reaching the filter from the tank by disconnecting the tank line to filter as a check.

   b. With the engine turned off and all lines connected, open the fuel tank shut-off valve fully.

   c. Open the drain cock in the filter base and allow the fuel to drain for a short period. Then, close the drain cock.

   d. Open the bleed screw at the filter cover and allow fuel to escape until all air bubbles disappear. Then, close the bleed screw.
2. To detect faulty injectors, it is necessary only to disconnect the pressure lines at each injector as follows:

   a. With the engine running at approximately 800 rpm, disconnect one injector line and listen for a drop in speed or a rougher engine performance.

   b. Check each injector in the same manner until the faulty unit or units are found.

   NOTE: ***When injectors are disconnected, observe to see if an equal volume of fuel is being pumped through the lines. If it is not, the line may be restricted or the pump could be faulty.***
3. Check cylinder compression as follows:

   a. Be sure the battery is up to specifications. Operate the engine for a minimum of ½ hour at 1200 rpm, then stop the engine.

   b. Move the hand throttle to the closed position. Turn the fuel shut-off valve to the closed position.

   c. Remove the injector and seat washer from No. 1 cylinder.

   d. Clean the injector bore and crank the engine to blow out any loose carbon particles.

   e. Install the Compression Gauge Adapter (5) from Compression Gauge Kit N-1000-BB in the No. 1 injector bore using a new seat washer and the injector mounting bolts.

   f. Connect Compression Gauge and Hose to the Adapter.

   g. Start the engine and accelerate to 1400 rpm and observe the gauge needle which should be approximately 490 psi.

   If the pressure gauge is below normal by more than 20 pounds, excessive ring to cylinder wall clearance is indicated or the valves are sticking. Squirt a small amount of engine oil into each cylinder and crank the engine again. If the pressure reads normal on the gauge, the rings or cylinders need servicing. However, if the pressure is still below normal, the valves are not sealing and need regrinding. Check each cylinder in turn in the same manner.

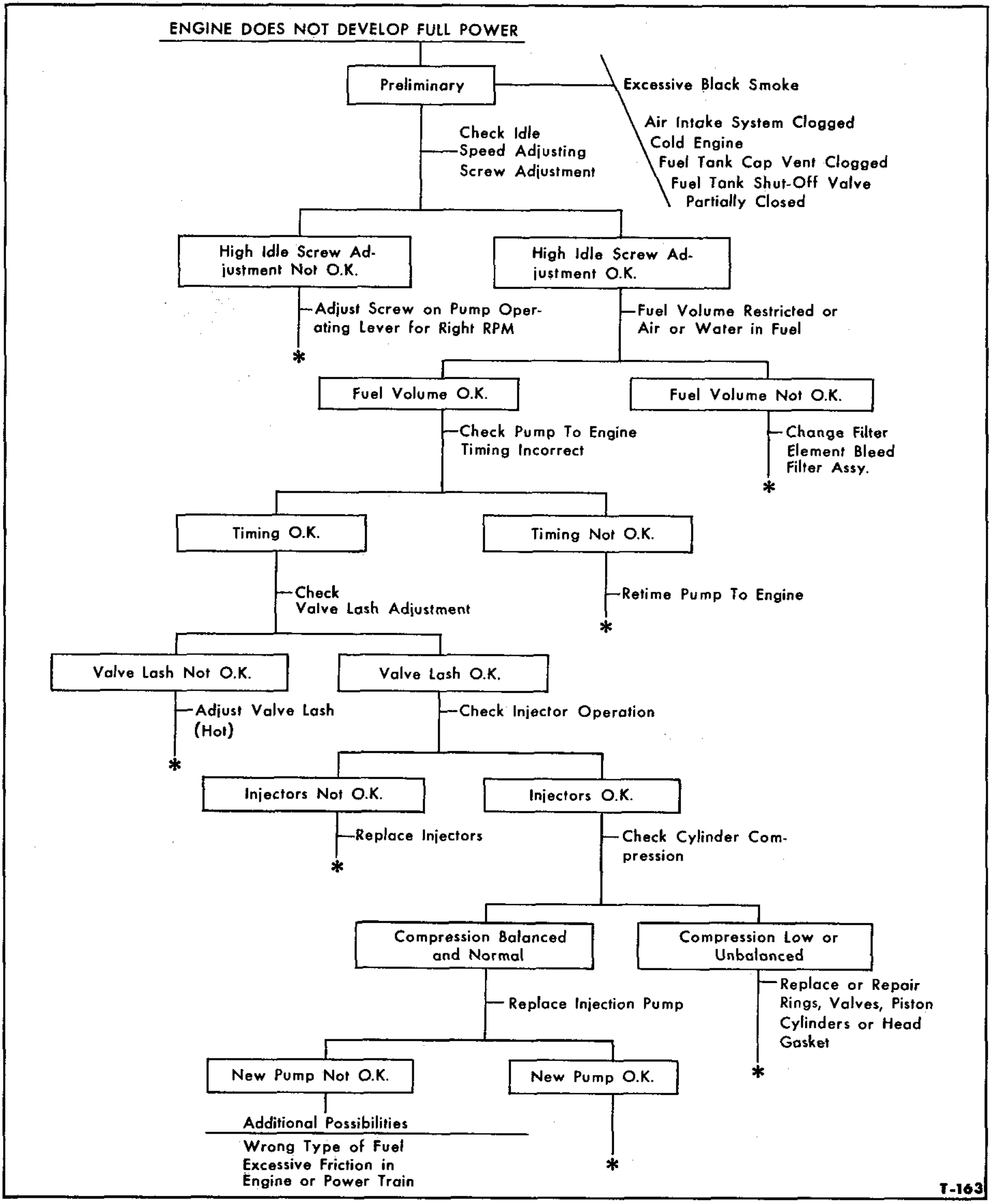

ENGINE DOES NOT DEVELOP FULL POWER
Preliminary
Excessive Black Smoke
Air Intake System Clogged
Cold Engine
Fuel Tank Cap Vent Clogged
Fuel Tank Shut-Off Valve Partially Closed
Check Idle Speed Adjusting Screw Adjustment
High Idle Screw Adjustment Not O.K.
Adjust Screw on Pump Operating Lever for Right RPM
*
High Idle Screw Adjustment O.K.
Fuel Volume Restricted or Air or Water in Fuel
Fuel Volume O.K.
Check Pump To Engine Timing Incorrect
Fuel Volume Not O.K.
Change Filter Element Bleed Filter Assy.
*
Timing O.K.
Check Valve Lash Adjustment
Timing Not O.K.
Retime Pump To Engine
*
Valve Lash Not O.K.
Adjust Valve Lash (Hot)
*
Valve Lash O.K.
Check Injector Operation
Injectors Not O.K.
Replace Injectors
*
Injectors O.K.
Check Cylinder Compression
Compression Balanced and Normal
Replace Injection Pump
Compression Low or Unbalanced
Replace or Repair Rings, Valves, Piston Cylinders or Head Gasket
*
New Pump Not O.K.
Additional Possibilities
Wrong Type of Fuel
Excessive Friction in Engine or Power Train
New Pump O.K.
*
T-163

Figure 76—Engine Does Not Develop Full Power—Road Map

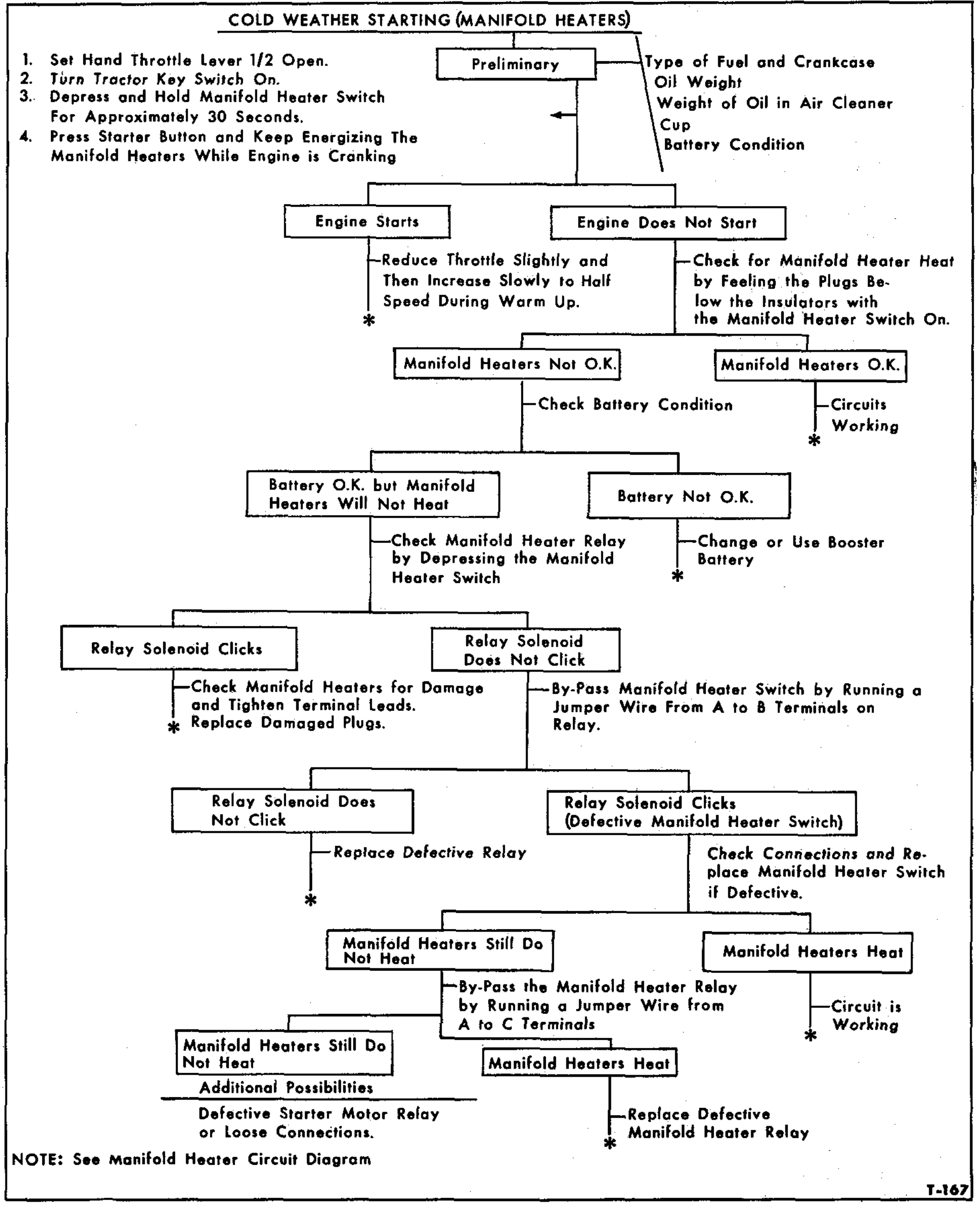

COLD WEATHER STARTING (MANIFOLD HEATERS)
1. Set Hand Throttle Lever 1/2 Open.
2. Turn Tractor Key Switch On.
3. Depress and Hold Manifold Heater Switch For Approximately 30 Seconds.
4. Press Starter Button and Keep Energizing The Manifold Heaters While Engine is Cranking
Preliminary
Type of Fuel and Crankcase Oil Weight
Weight of Oil in Air Cleaner Cup
Battery Condition
Engine Starts
Reduce Throttle Slightly and Then Increase Slowly to Half Speed During Warm Up.
*
Engine Does Not Start
Check for Manifold Heater Heat by Feeling the Plugs Below the Insulators with the Manifold Heater Switch On.
Manifold Heaters Not O.K.
Check Battery Condition
Manifold Heaters O.K.
Circuits Working
*
Battery O.K. but Manifold Heaters Will Not Heat
Check Manifold Heater Relay by Depressing the Manifold Heater Switch
Battery Not O.K.
Change or Use Booster Battery
*
Relay Solenoid Clicks
Check Manifold Heaters for Damage and Tighten Terminal Leads. Replace Damaged Plugs.
*
Relay Solenoid Does Not Click
By-Pass Manifold Heater Switch by Running a Jumper Wire From A to B Terminals on Relay.
Relay Solenoid Does Not Click
Replace Defective Relay
*
Relay Solenoid Clicks (Defective Manifold Heater Switch)
Check Connections and Replace Manifold Heater Switch if Defective.
Manifold Heaters Still Do Not Heat
By-Pass the Manifold Heater Relay by Running a Jumper Wire from A to C Terminals
Manifold Heaters Heat
Circuit is Working
*
Manifold Heaters Still Do Not Heat
Additional Possibilities
Defective Starter Motor Relay or Loose Connections.
Manifold Heaters Heat
Replace Defective Manifold Heater Relay
*
NOTE: See Manifold Heater Circuit Diagram
T-167

Figure 77—Cold Weather Starting

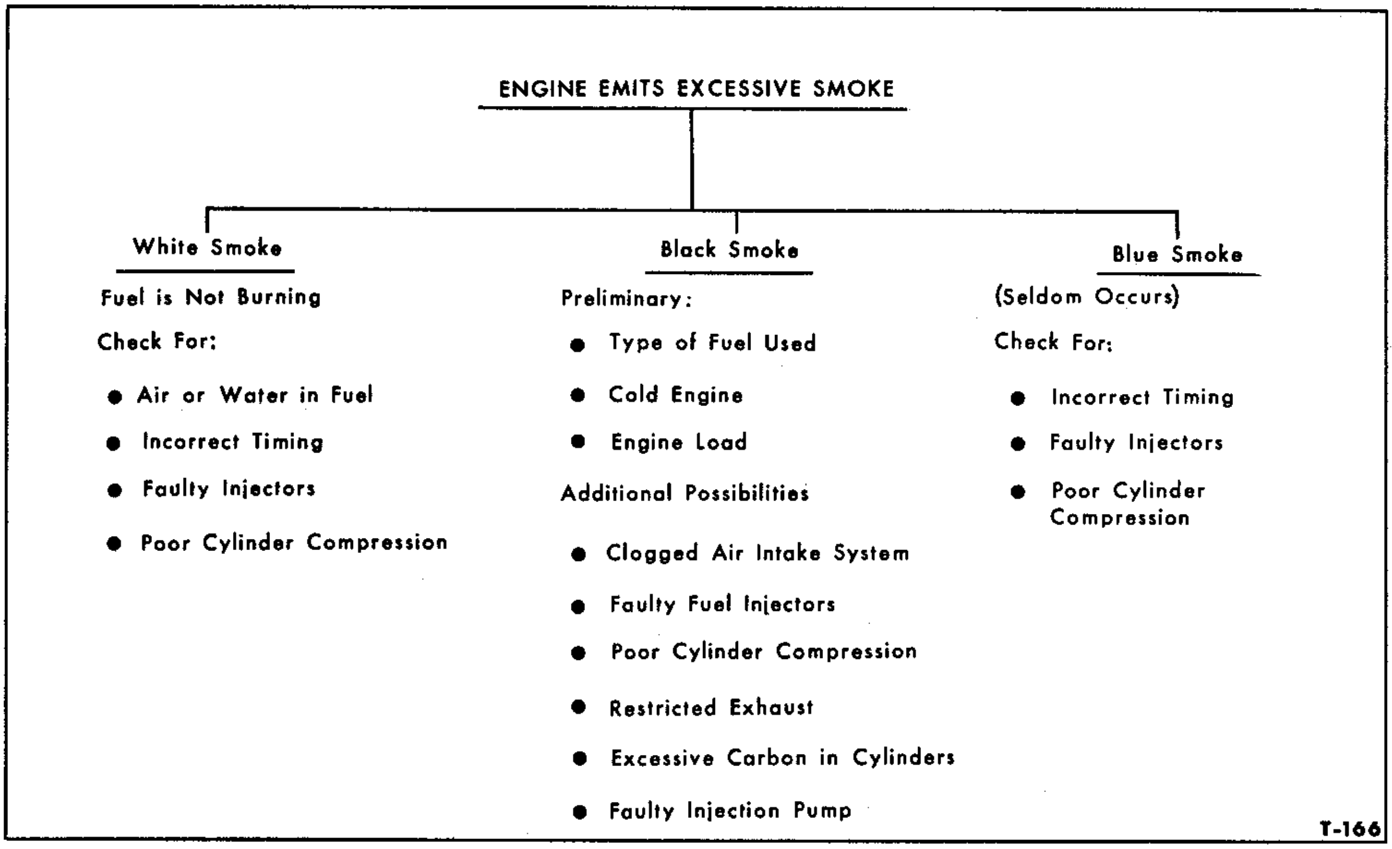


Figure 78—Engine Emits Excessive Smoke

11. SPECIFICATIONS

There are four different engines used in Ford Tractors, 134 cu. in. gas, 172 cu. in. gas, 144 cu. in. diesel, and 172 cu. in. diesel. The gasoline and LP-Gas engines are basically the same with the exception of carburetion, therefore all specifications listed under gasoline engines, will also apply for the LP-Gas engines. When reference is made to engine models, it will be 134 and 172 cu. in. gasoline or 144 and 172 cu. in. diesel.

Engine No. of Cylinders	134 Cu. In. Gasoline 4	172 Cu. In. Gasoline 4	144 Cu. In. Diesel 4	172 Cu. In. Diesel 4
Valve Arrangement	Overhead	Overhead	Overhead	Overhead
*Horsepower (brake)	48.4 @ 2200 rpm	62.6 @ 2200 rpm	42.7 @ 2200 rpm	56.3 @ 2200 rpm
Bore	3.44	3.90	3.56	3.90
Stroke	3.60	3.60	3.60	3.60
Displacement	134 Cu. In.	172 Cu. In.	144 Cu. In.	172 Cu. In.
Compression at Sea Level	205 PSI @ 1000 rpm	205 PSI @ 1000 rpm	483 PSI @ 1000 rpm	554 PSI @ 1000 rpm
Firing Order	1-2-4-3	1-2-4-3	1-2-4-3	1-2-4-3
Oil Capacity Refill Initial	 4 qts. 5 qts.	 4 qts. 5 qts.	 4 qts. 5 qts.	 4 qts. 5 qts.
Compression Ratio	7.5:1	7.5:1	16.8:1	16.8:1
*Torque ft. lbs. at rpm	1268 @ 1600 rpm	166 @ 1600 rpm	111.3 @ 1400 rpm	140.4 @ 1400 rpm

*Less air cleaner, fan and muffler.

GASOLINE ENGINES

Pistons

Type	Autothermic Cam Ground					
Part No.	Fitting New Piston in New Bore		Fitting New Piston in Used Bore		Fitting Used Piston in Used Bore	
	Gauge Thickness (Inches)	Pounds Pull	Gauge Thickness (Inches)	Pounds Pull	Gauge Thickness (Inches)	Pounds Pull
EAE-6108-F	0.0015	5-10	0.002	5-10	0.003	5-10
EAF-6108-F	0.0015	5-10	0.002	5-10	0.003	5-10

DIESEL ENGINES

Pistons

Type Part No.	Fitting New Piston in New Bore		Solid Trunk—Cam Ground Fitting New Piston in Used Bore		Fitting Used Piston in Used Bore	
	Gauge Thickness (Inches)	Pounds Pull	Gauge Thickness (Inches)	Pounds Pull	Gauge Thickness (Inches)	Pounds Pull
B9NN-6108-A	0.005	5-18	0.006	5-18	0.007	5-18
311996	0.005	5-10	0.006	5-10	0.007	5-10

GASOLINE ENGINES

Piston Rings

	Side Clearance			End Clearance and Oversize	
Part No.	Top Ring (Inches)	Second Ring (Inches)	Oil Ring (Inches)	End Clearance (Inches)	Oversize Available (Inches)
CPN-6149-B	0.002 0.0035	0.0015 0.0035	0.0015 0.003	0.010 0.020	0.020 - 0.030 - 0.040
FPN-6149-A	0.002 0.0035	0.002 0.0035	0.0015 0.003	0.010 0.020	0.020 - 0.030 - 0.040

DIESEL ENGINES

Piston Rings

	Side Clearance				End Clearance and Oversize	
Part No.	Top Ring (Inches)	2nd and 3rd Rings (Inches)	Upper Oil Ring (Inches)	Lower Oil Ring (Inches)	End Clearance (Inches)	Oversize Available (Inches)
JPN-6149-A	0.004 0.006	0.002 0.004	0.0015 0.0035	0.0015 0.0035	0.010 0.020	0.020 - 0.030 - 0.040
HPN-6149-A	0.0035 0.005	0.0015 0.0025	0.0015 0.003		0.010 0.020	0.020 - 0.030 - 0.040

GASOLINE AND DIESEL ENGINES

Piston Pins

Part No.	Diameter (Inches)	Length (Inches)	Clearance in Rod Bushing (Inches)	Clearance in Piston (Inches)
EAE-6135-B	0.9120 0.9123	2.930 2.942	0.0004 0.001	0.0001 0.0005

GASOLINE AND DIESEL ENGINES

Piston Pins—Cont'd

Part No.	Diameter (Inches)	Length (Inches)	Clearance in Rod Bushing (Inches)	Clearance in Piston (Inches)
EAD-6135-B	0.9120 0.9123	3.220 3.232	0.0002 0.0008	0.0001 0.0005
B9NN-6135-A	1.1240 1.1243	2.930 2.942	0.0004 0.0007	0.0001 0.0003
310640	1.2490 1.2493	3.220 3.232	0.0004 0.0007	0.0001 0.0003

CONNECTING ROD ALIGNMENT

Part No.	Max. Bend (Inches)	Max. Twist (Inches)	Bushing I.D. (Inches)
EAA-6200-B	0.0005	0.0015	0.9122 0.9125
B9NN-6200-A	0.0005	0.0015	1.1247 1.1250
312731	0.0005	0.0015	1.2490 1.2493

CRANKSHAFT JOURNAL DIAMETERS

Part No.	Crankpin (Inches)	Main Journal (Inches)
EAF-6303-D	2.2988 2.2978	2.4974 2.4988
310731	2.2988 2.2978	2.4974 2.4988

GASOLINE AND DIESEL ENGINES

Connecting Rod Bearings

Part Number	Bearing Oil Clearance (Inches)	Connecting Rod Side Clearance (Inches)	Undersize Bearings Available (Inches)
EAG-6211-G	0.0004 0.002	0.003 0.009	0.001 - 0.002 0.010 - 0.020
312026	0.0004 0.002	0.003 0.009	0.001 - 0.002 0.010 - 0.020

GASOLINE AND DIESEL ENGINES

Main Bearings

Part Number	Bearing Oil Clearance (Inches)	Crankshaft End Play (Inches)	Undersize Bearings Available (Inches)
EAF-6331-A	0.0007 0.0023	0.002 0.006	0.001 - 0.002 0.010 - 0.020
EAF-6342-C	0.0007 0.0023	0.002 0.006	0.001 - 0.002 0.010 - 0.020
312146	0.0007 0.0023	0.002 0.006	0.001 - 0.002 0.010 - 0.020
311980	0.0007 0.0023	0.002 0.006	0.001 - 0.002 0.010 - 0.020

GASOLINE AND DIESEL ENGINES

Camshaft

Part Number	Gear Lash (Inches)	End Play (Inches)	Journal Diameter (Inches)	Oil Clearance (Inches)
310377	0.002 - 0.006	0.003 - 0.007	1.925 - 1.926	0.0015 - 0.0035

GASOLINE AND DIESEL ENGINES

Valves

Part Number	Face Angle (Inches)	Stem Diameter (Inches)	Stem to Guide Clearance (Inches)	Valve Lash (Inches)	Cap to Stem End Clearance (Inches)
EAF-6505-D (Exhaust)	46 Degrees	0.3405 0.3415	0.001 0.002	0.014 0.016	0.002 0.004
B9NN-6505-A (Exhaust)	46 Degrees	0.3405 0.3415	0.001 0.002	0.014 0.016	0.002 0.004
310651 (Exhaust)	46 Degrees	0.3405 0.3415	0.001 0.002	0.014 0.016	0.002 0.004
EBU-6507-A (Intake)	46 Degrees	0.3415 0.3425	0.001 0.002	0.014 0.016	
B9NN-6507-A (Intake)	46 Degrees	0.3416 0.3423	0.001 0.002	0.014 0.016	
310650 (Intake)	46 Degrees	0.3416 0.3423	0.001 0.002	0.014 0.016	

GASOLINE AND DIESEL ENGINES

Valve Seats

Part No.	Valve	Seat Angle	Seat Runout (Inches)	Removable	Seat Width (Inches)
40-6057-B	Intake	45 Degrees	0.002	No	0.060 - 0.080
	Exhaust	45 Degrees	0.002	Insert	0.090 - 0.110

GASOLINE AND DIESEL ENGINES

Valve Guides

Part Number	Inside Diameter (Inches)	Guide to Valve Stem Clearance (Inches)	Removable
EAF-6510-C	0.3436 0.3444	0.001 0.002	Yes
311411	0.3436 0.3444	0.001 0.002	Yes

GASOLINE AND DIESEL ENGINES

Valve Timing and Lift

Engine	Valve Lash for Timing	Intake Opens	Intake Closes	Exhaust Opens	Exhaust Closes	Valve Lift (Inches)	
						Intake	Exhaust
ALL	0.015 (Hot)	Before T.D.C. 15 Degrees	After B.D.C. 35 Degrees	Before B.D.C. 41 Degrees	After T.D.C. 15 Degrees	.3553	.3370

GASOLINE AND DIESEL ENGINES

Valve Springs

Part Number	Test Length (Inches)	Pounds Pressure	Dampening Coils
EAA-6513-A	1.821 1.505	Closed— 54-62 Lbs. Open—124-140 Lbs.	Installed Down

GASOLINE AND DIESEL ENGINES

Valve Tappets

Part Number	Bore Clearance (Inches)	Tappet Diameter (Inches)
EAA-6500-D	0.0005 0.0021	0.4989 0.4995

GASOLINE AND DIESEL ENGINES

Oil Pump Assembly

Part Number	Drive Shaft to Body Clearance (Inches)	Driven Gear to Pin Clearance (Inches)	Gear to Pump Body Side Clearance (Inches)	Relief Valve Spring Tension
B9NN-6621-A	0.0015 - 0.0029	0.001 - 0.002	0.005 Max.	9.8 lbs. ± 4 oz. at 1.56"

GASOLINE AND DIESEL ENGINES

Cylinder Sleeve Bore Diameter Taper and Micro Finish

Engine	Micro Finish	Sleeves	Taper (Inches)	Out of Round (Inches)	Diameter (Inches)
134 Cu. In.	25 - 35	Yes	0.001 in 6 Inches	0.0005	3.4368 - 3.4388
144 Cu. In.	25 - 35	No	0.001 in 6 Inches	0.0005	
172 Cu. In.	25 - 35	Yes	0.001 in 6 Inches	0.005	3.8998 - 3.9018

GASOLINE AND DIESEL ENGINES

Rocker Shaft and Supports

Part Number	Journal Diameter (Inches)	Support I.D. (Inches)	Material
EAF-6563-B	0.780 0.781	0.783 0.785	Aluminum
EAA-6531-A	0.780 0.781	0.783 0.785	Aluminum
EAA-6532-A	0.780 0.781	0.783 0.785	Aluminum
310635	0.780 0.781	0.783 0.785	Cast Iron

Torque Limits	Foot Pounds
Valve Rocker Arm Cover	1¼-2 in. lbs.
Cylinder Head Bolts	65-70 (Gasoline) 100-105 (Diesel)
Valve Rocker Arm Support to Cylinder Head	45-55
Valve Push Rod Chamber Cover	20-30 in. lbs.
Fuel Injectors to Cylinder Head	15-18
Bleed Back Line to Fuel Injectors	6-9
Manifolds to Cylinder Block	40-50
Water Outlet Elbow	8-10
Water Pump to Cylinder Block	10-15
Camshaft Thrust Plate to Cylinder Block	12-16

Torque Limits	Foot Pounds
Cylinder Front Cover	10-15
Main Bearing Cap Bolts	100-105
Connecting Rod Nuts	45-50
Connecting Rod Pal Nuts	3-4
Flywheel to Crankshaft	75-85
Crankshaft Pulley to Crankshaft	100-110
Oil Pump to Cylinder Block	30-35
Oil Tubes to Oil Pump Cover Plate	10-15
Oil Pan to Cylinder Block	12-15
Model 501 only	20-25
Hydraulic Pump Gear Cover to Cylinder Block	18-21

12—SPECIAL TOOLS

The following tools are used to overhaul the engine and are illustrated in the preceding sections of the manual:

Tool No.	Description
818	Driver Set—Bushing
T-818	Driver Set—Heavy Duty Bushing
6510-AF	Driver—Valve Guide
6701-A	Forming Tool—Crankshaft Rear Oil Seal
6149-9	Piston Ring Expander—134 cu. in. Engine
N-630	Piston Ring Expander—172 cu. in. Engine
LM-6110	Piston Ring Groove Cleaner
FT-970	Puller and Installer—Cylinder Sleeve
6207-D	Reamer—Connecting Rod Bushing
7600-E	Remover—Clutch Pilot Bearing
6306-AE	Remover—Crankshaft Gear
18182	Remover and Replacer—Governor Needle Bearing
3600-E	Scale—Piston Pull (0-25 in. lbs.)
6149	Compressor—Piston Ring
850-T	Compressor—Piston Ring (Diesel)
6513-EE	Compressor—Valve Spring
UTC-48	Gauge—Compression (0-300 P.S.I.)
N-1000-BB	Gauge—Compression (0-800 P.S.I.) (Diesel)
6011-E	Reamer—Cylinder Ridge
6207-C	Remover and Replacer—Connecting Rod Bushing
6306-AF	Replaced—Crankshaft Gear
6085-F	Fixture—Cylinder Head Overhaul
6000-KAD	Fixture—Engine Lifting

Part ONE

POWER PLANT

Chapter

II

Electrical System

Section **Page**
1 Battery 60
2 Generator and Charging Circuit 61
3 Starting Motor, Solenoid and Starting Circuit 69
4 Lamps and Lighting Circuit 73
5 Manifold Heaters, Relay and Electrical Circuit—DIESEL 75
6 Trouble Shooting 76
7 Specifications 82
8 Special Tools 82

The electrical system consists of the starting system, charging system, ignition system (Gasoline and LP-Gas models only), and the lighting system.

A six-volt positive ground electrical system is used on all gasoline and LP-Gas powered Ford Tractors, whereas, a twelve-volt negative ground electrical system is used on all Ford Diesel Tractors.

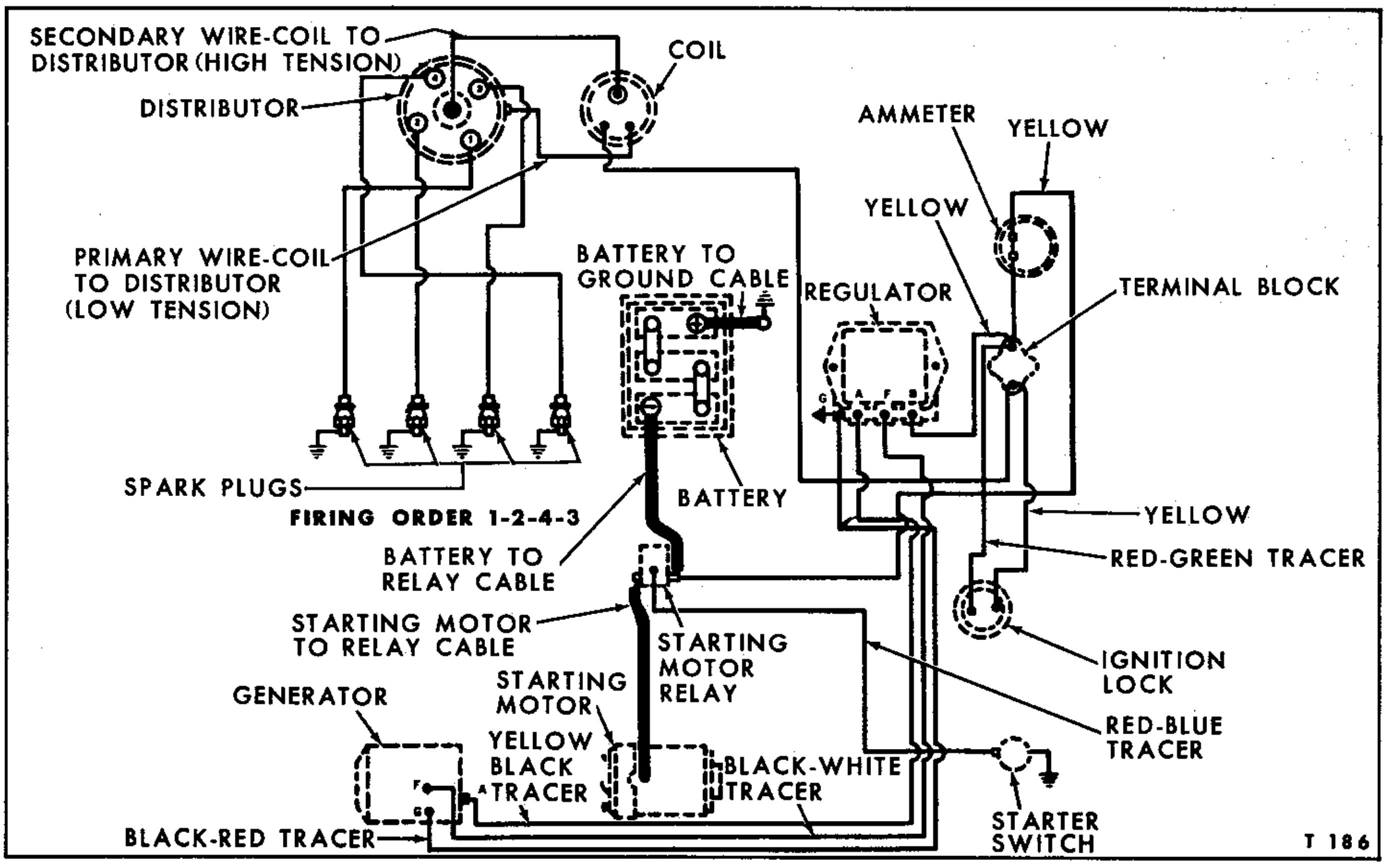
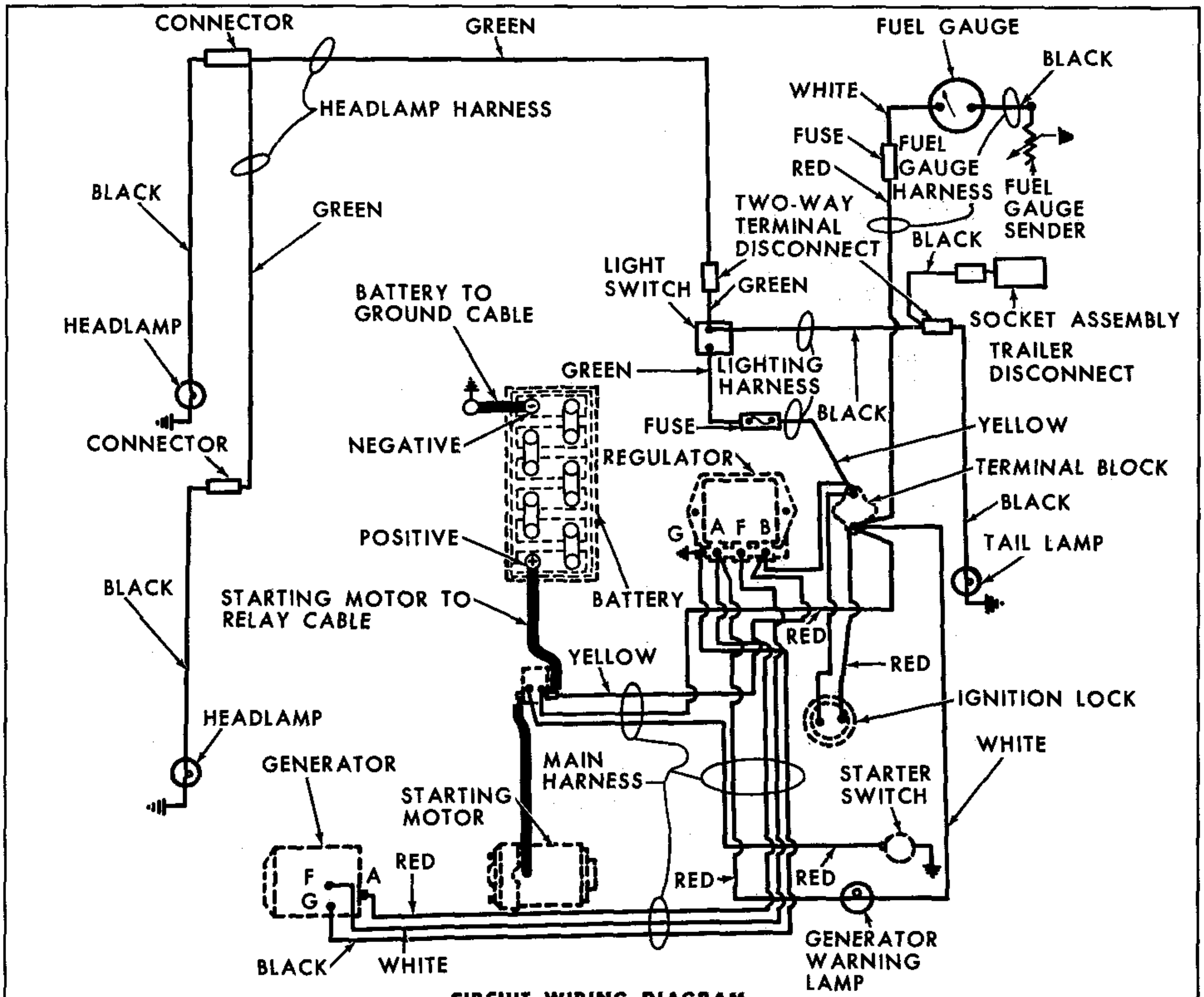


Figure 1—Electrical System Wiring Diagram 6—Volt



CIRCUIT WIRING DIAGRAM
12-VOLT SYSTEM

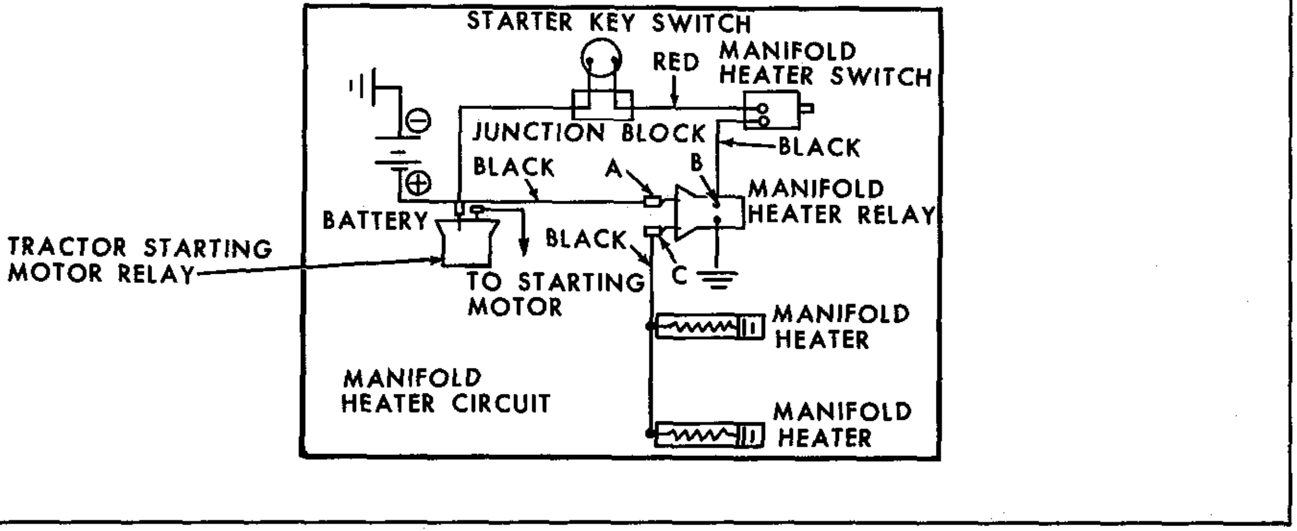


Figure 2—Electrical System Wiring Diagram 12—Volt

1. BATTERY

The battery is used to convert chemical energy into electrical energy and is the source of current in all Ford Tractor electrical systems. Its primary function is to provide current for the ignition and starting systems to start the engine. After the engine has been started, the generator will replenish the current in the battery that was used when starting the engine. In addition to keeping the battery charged, the generating system supplies current for ignition, lights and electrical accessories.

A. Maintenance

1. Check the level of the electrolyte at regular intervals to make certain that it is at the ring in the filler holes. If it is lower than the rings, bring it to the proper level by adding distilled or purified tap water.
2. Battery terminals should be kept tight and free of corrosion. Two tablespoons of baking soda mixed with one pint of water makes a satisfactory solution for cleaning terminals, battery case and battery support. Plug all vent holes to prevent entry of cleaning solution. After cleaning, the soda water should be rinsed away with clean water. Apply a small portion of petroleum jelly to the terminals to counteract corrosion. Remove plugs from vent holes.
3. Check the specific gravity of the battery with a hydrometer. Compare the hydrometer reading with the Battery Specific Gravity Chart to determine the state of charge.

BATTERY SPECIFIC GRAVITY CHARGE

State of Charge	Specific Gravity Temperate Climates
Fully Charged	1.275
75%	1.250
50%	1.225
25%	1.200
Discharged	1.175

Hydrometer readings will be accurate in temperature from 70°F. to 90°F. Readings must be compensated to .004 specific gravity for each 10°F. For every 10° above 80° add .004 gravity points and for every 10° below 80° subtract .004 gravity points. For example, an uncorrected reading of 1.225 specific gravity with an acid temperature of 0°F., would indicate a 50% charged battery. However, with a temperature correction of .004 specific gravity for each 10°F. change from the reference temperature of 80°F. or .032 specific gravity (8 x .004=.032), the correct reading would be 1.193 specific gravity (1.225—.032= 1.193) or approximately a 25% charged battery. Most hydrometers have a thermometer and correction scale built in so that a temperature correction can be readily made.

B. Removal

1. Disconnect the battery ground cable (— cable diesel tractors and + cable on all others).
2. Remove the nut and washer from each hold-down clamp bar and remove the bars.
3. Remove the battery and hold-down clamp from the battery support. Lift the clamp from the battery.

C. Installation

1. Make certain that the electrolyte is at the proper level and that the battery is fully charged.
2. Position the hold-down clamp on the battery. Place the battery on the battery support.

   NOTE: ***The positive post of a six-volt battery must be toward the right side of the tractor while the negative post of a twelve-volt battery must be toward the right side of the tractor.***

3. Secure the battery with the two hold-down bars, washers and nuts. Tighten the nuts only enough to prevent the battery from shifting on the support.
4. Connect each battery cable to its respective post.

   IMPORTANT: ***Always connect the ground cable last.***

D. Light Load Battery Test

1. Disconnect the coil to distributor secondary wire from the coil on LP-Gas or gasoline models. On diesel models, place the throttle lever in the closed position.
2. Crank the engine from 3 to 5 seconds to stabilize battery voltage.
3. Turn the headlights on and, after one minute, check each battery cell with an O-4 voltmeter. Record the readings.
4. If all cell readings are 1.95 volts or more and variation is less than 0.5 volt between all cells, the battery is in good condition.
5. If any cell reads less than 1.95 volts and variation is less than 0.5 volt between all cells,

charge the battery and repeat the test. Likewise if all cell readings are less than 1.95 volts, charge the battery and repeat the test.

6. If cell readings are 1.95 volts or more and vary more than 0.5 volt, replace the battery.
7. A battery that is in good condition should be charged until a hydrometer reading of 1.230–1.275 is obtained.
8. Connect the secondary wire to the coil if it was previously disconnected.

E. Charging the Battery

1. Wash all dirt from the battery and clean its terminals before placing it on charge. Do not allow dirt to enter the cells. Bring the liquid level in the cells up to the fill ring. Allow the battery to warm up before adding water as the level will rise as it warms.
2. Slow charging is the only method which will *fully* charge a battery. Slow charging should be at a rate of 3 to 4 amperes for a sufficient length of time to fully charge the battery. The battery is fully charged when the cells are all gassing freely and the gravity ceases to rise for three successive readings taken at hourly intervals. Do not stop charging short of the fully charged state, even if it requires charging for 24 hours or more. A battery which is badly sulphated may not take a charge or will require more charging time than a normal battery.
3. A fast charger has the ability to quickly "boost" a battery without removing it from the tractor. However, a high rate charger may be used, to quickly "boost" a battery. *A high rate charge must always be followed by slow charging* for a length of time necessary to bring the battery to full charge. Follow the instructions provided by the manufacturer of the fast charger being used.

NOTE: ***Charging batteries at a high rate causes the temperature of the electrolyte to rise and may cause violent gassing of the electrolyte, unless the equipment is provided with an automatic time limiting or temperature limiting device to protect the battery electrolyte from exceeding a temperature of 125° F. and gassing excessively.***

2. GENERATOR AND CHARGING CIRCUIT

The charging circuit consists of the battery, generator, generator regulator, charge indicator light and the necessary wiring. A shunt wound two pole type generator provides the electrical energy necessary to keep the battery fully charged. Generator output is controlled by a two unit regulator consisting of the cutout relay and a voltage current regulator. Before attempting any repairs in the charging circuit, make certain that the fan belt is properly adjusted and that terminal connections are tight, then perform the following tests to determine which unit is at fault:

GENERATOR

A. Generator Output Test

1. Disconnect the armature (red) wire from the terminal on the generator. Connect a jumper wire across the armature and field terminals as shown in Figure 3.
2. Connect the negative lead of an O-75 ammeter to the generator armature terminal (six-volt system only).

NOTE: ***On twelve volt systems, connect the ammeter positive lead to the generator armature terminal.***

3. Connect the other ammeter lead to the terminal of the armature wire as shown in Figure 3.
4. Start the engine and gradually increase the engine speed to 1500 rpm while observing the ammeter. The generator output should reach or exceed 20 amperes.

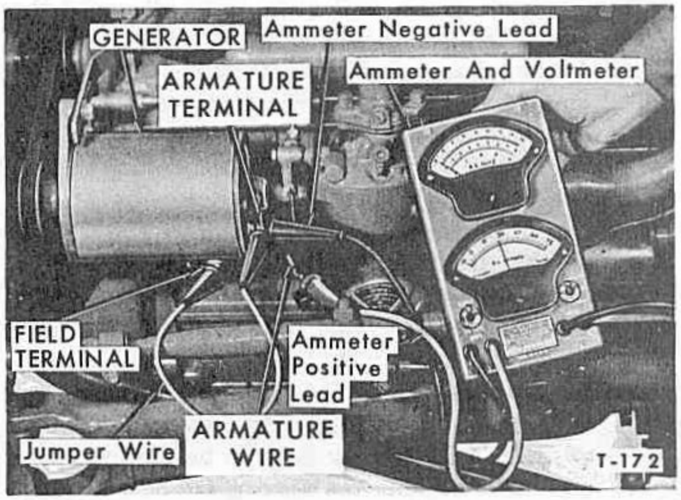


Figure 3—Generator Output Test Connections

NOTE: *Stop the engine and disconnect the jumper wire from the field and armature terminals as soon as the generator output is obtained to prevent overheating the generator.*

5. If the generator output is below 20 amperes or is erratic, check the generator belt tension and adjust if necessary. Repeat the test. If adjusting the belt does not increase the generator output to 20 amperes, remove and repair or replace the generator.

B. Voltage Limiter and Cutout Tests

1. Prior to checking the generator regulator, the following three components of the electrical system must be checked, and their condition known. The wiring harness must be inspected and all connections checked for cleanliness and tightness. Corroded or dirty terminals cause high resistance which hampers the performance of the system. Bare wiring must be replaced or repaired. The generator output test must be made to be sure it is working satisfactorily and the battery specific gravity must be checked to determine its state of charge. If specific gravity is below 1.250, the battery must be charged or replaced with a fully charged battery.

2. With the ammeter wires still connected as in the generator output test, (with the exception of the jumper wire) connect the voltmeter negative lead to the ammeter positive lead.

   NOTE: *If working on a twelve-volt system, connect the voltmeter positive lead to the ammeter negative lead.*

   Connect the other voltmeter lead to ground as shown in Figure 4.

3. Start the engine and allow it to idle until the regulator reaches normal operating temperature (obtained after a 30 minute run at a 4.5 to 5.0 amp charge rate). Slowly increase the engine speed to 1500-2000 rpm while observing the ammeter and voltmeter. Cutout closing will be indicated by a "flick" of the voltmeter pointer and a rise of the ammeter pointer. The voltage at the time the voltmeter pointer "flicks" or momentarily drops back, will be the cutout closing voltage. The cutout closing voltage should be 6.0-6.6 volts for a six-volt system with the regulator at 80°F., or 12.2-13.0 for a twelve-volt system under the same temperature conditions. This test may have to be repeated several times to note the flicking of the voltmeter pointer.

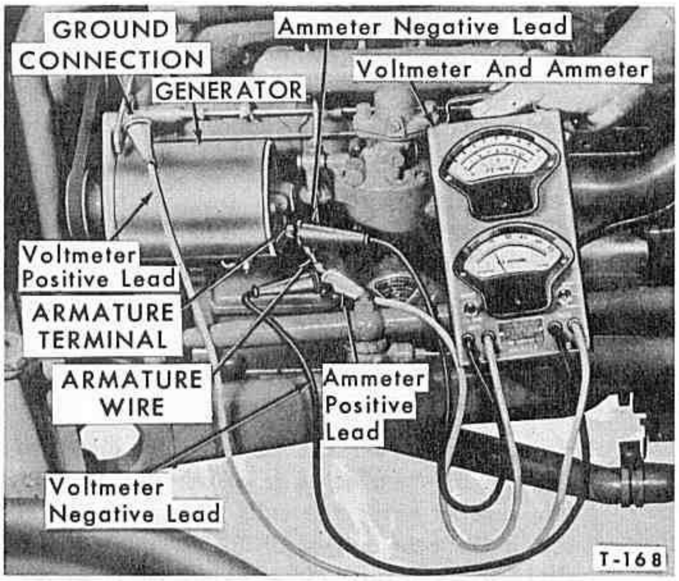


Figure 4—Generator Regulator Test Connections

   Replace the voltage regulator if not within specifications.

4. Read the regulated voltage on the voltmeter which is connected from the regulator "arm" terminal to ground. The following tables give

SIX-VOLT SYSTEM

Temp. 0° F.	Volts	Temp. 0° F.	Volts
20	7.65-8.05	65	7.20-7.60
25	7.60-8.00	70	7.15-7.55
30	7.55-7.95	75	7.10-7.50
35	7.50-7.90	80	7.05-7.45
40	7.45-7.85	85	7.00-7.40
45	7.40-7.80	90	6.94-7.35
50	7.35-7.75	95	6.90-7.30
55	7.30-7.70	100	6.85-7.25
60	7.25-7.65		

TWELVE-VOLT SYSTEM

20	15.15-15.95	65	14.7-15.5
25	15.1-15.9	70	14.65-15.45
30	15.05-15.85	75	14.6-15.4
35	15.0-15.80	80	14.55-15.35
40	14.95-15.7	85	14.47-15.27
45	14.9-15.7	90	14.4-15.2
50	14.85-15.65	95	14.33-15.13
55	14.8-15.6	100	14.25-15.05
60	14.75-15.55		

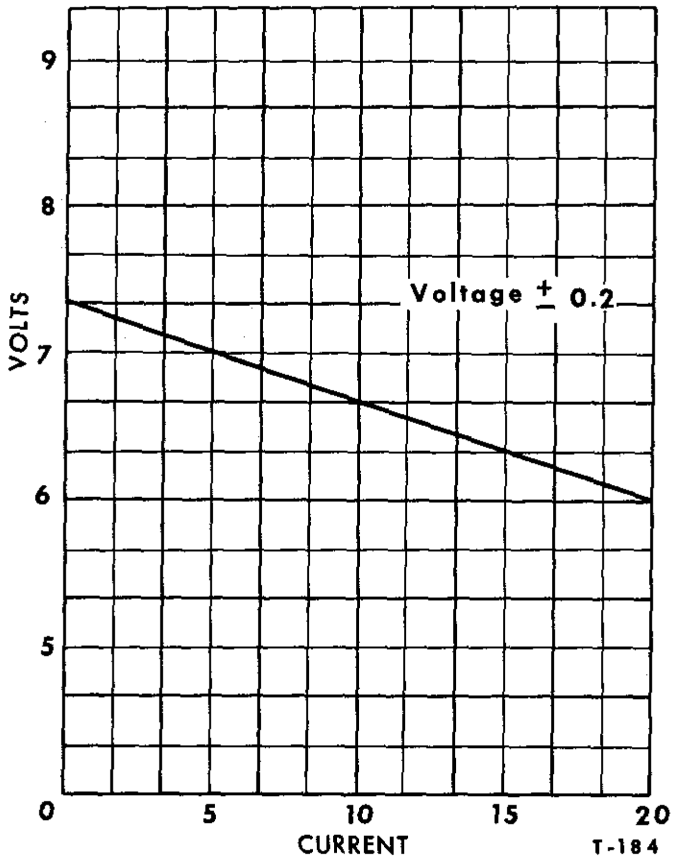


Figure 5—Six-Volt Regulator Test Curve

the proper setting of the voltage limiter for various temperatures when tested with a current of 4.5 to 5.5 amperes.

5. Disconnect the test leads and connect the armature wire to the armature terminal on the generator.

C. Generator Removal and Installation

1. Disconnect the armature, field and ground wires at the generator terminals.
2. Remove the adjustment arm to generator bolt, the generator belt, and the two pivot bolts from the mounting bracket. Then remove the generator.
3. Clean the mating surfaces of the generator and mounting bracket. Install the generator in the bracket with two pivot bolts and lockwashers. Install the generator belt, and the adjustment arm-to-generator bolt.
4. Adjust the belt tension and tighten all bolts securely. Install the armature, field, and ground leads on their respective terminals.

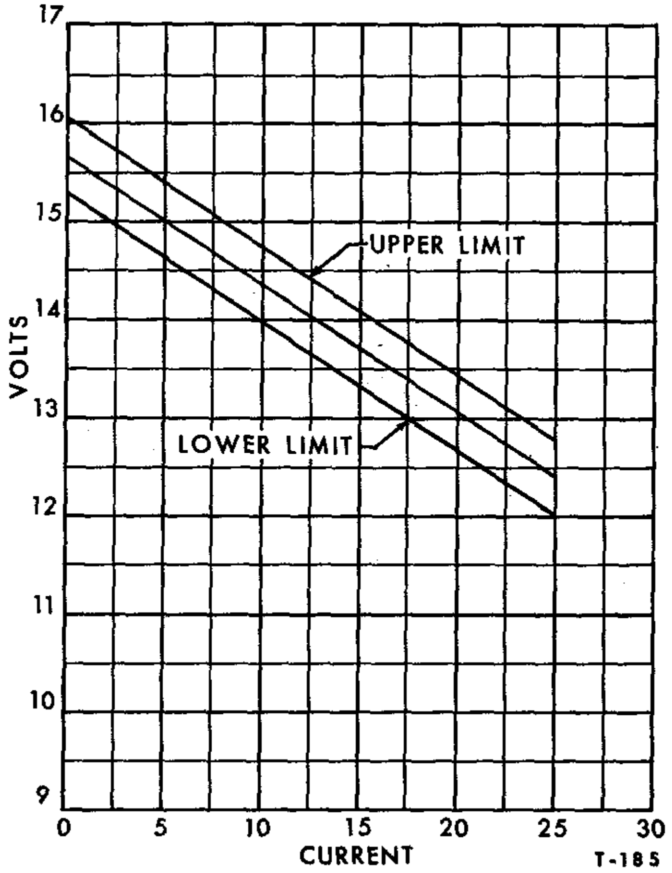


Figure 6—Twelve-Volt Regulator Test Curve

D. Generator Disassembly

1. Remove the through bolts, the rear end plate and the armature frame, Figure 7. When separating the generator, take care not to lose the dowel pins.
2. Clamp the armature in a vise equipped with soft metal jaws and remove the pulley retaining nut and lockwasher.
3. Use a suitable puller to remove the pulley, then pry the woodruff key out of the shaft and remove the front end plate.

   IMPORTANT: ***Always make an electrical test of brushes and brush holders and field coils for possible shorting before disassembly. Also check the front bearing and rear bearing or ball bearing for signs of wear or defects before removing them.***

4. Remove both brushes by removing the attaching screws. Remove the brush terminal screw, insulator, and brushes.
5. Remove the snap ring from the front end plate and remove the front bearing.

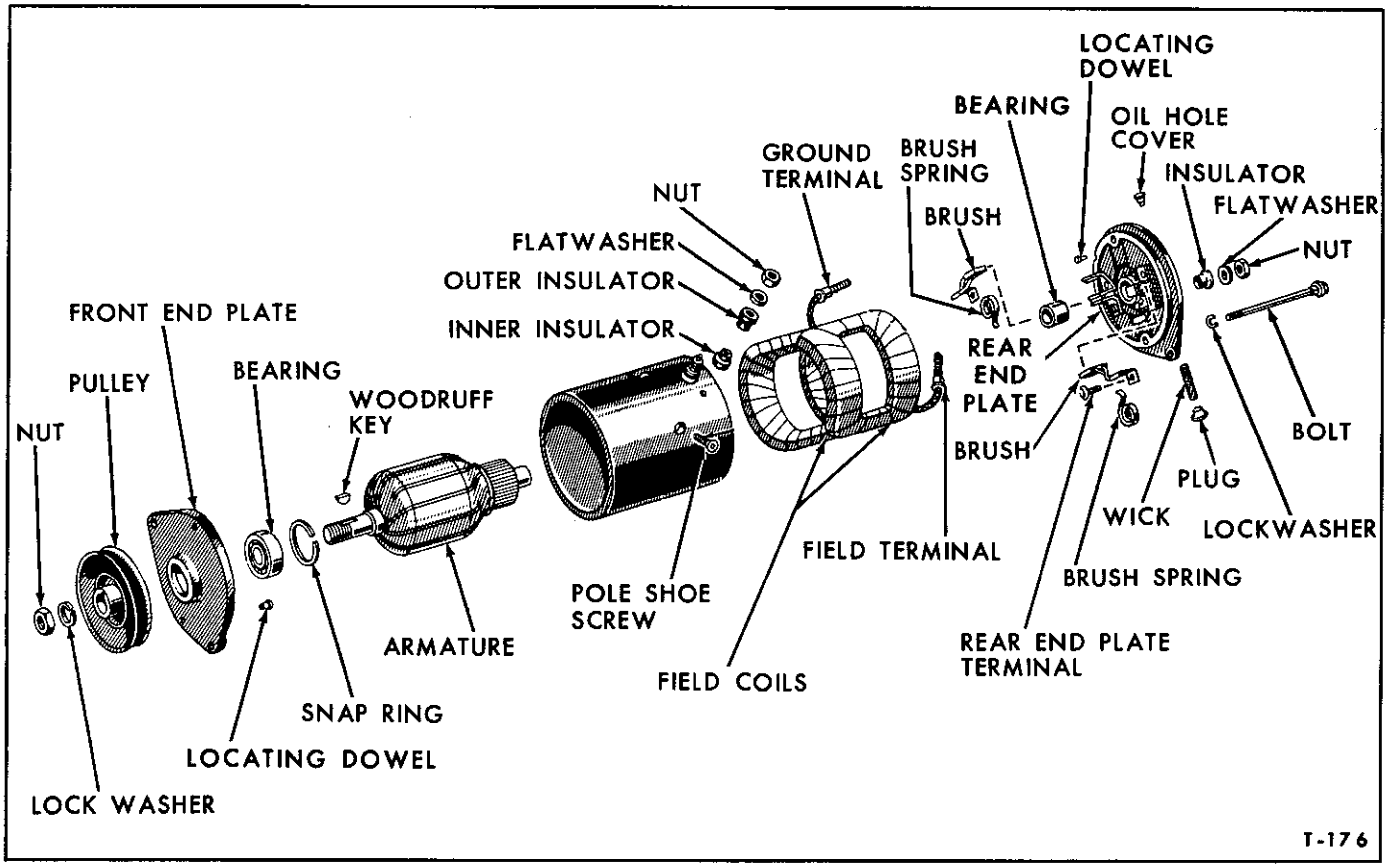


Fig. 7—Generator Disassembled

E. Generator Inspection—Visual

1. Replace the armature if the shaft is bent, worn or damaged. Turn the armature in a lathe if the commutator is rough or uneven, then undercut the mica. Solder broken connections with resin core solder.

2. Check brush holders to make certain that they are securely mounted. Make certain that the brushes slide freely in the holders. Replace bearings that are worn or damaged.

3. Replace brushes that are worn less than ½ inch in length.

4. Place the armature in the rear end plate and attach a tension scale to the brush spring as shown in Figure 8. Pull on the scale and note the reading when the spring leaves the brush. If not within 26-34 ounces (6-volt generator) or 32-40 ounces (12-volt generator), replace the springs.

5. Inspect the field coils in the armature trame for damaged or charred leads and replace if necessary.

F. Generator Electrical Tests

The following meters and equipment are required for making electrical tests on the generator and regulator.

O-20 Voltmeter
O-75 Ammeter
"Growler" Tester
Jumper Wires
6-Volt Storage Battery
12-Volt Storage Battery

Armature Tests:

1. Place the armature in a growler and rotate it slowly while holding a steel strip or hacksaw blade over the steel coils as shown in Figure 9. The steel strip will vibrate over a shorted coil. Replace the armature if a short circuit is found.

2. Check the armature for a grounded circuit by connecting a voltmeter between the battery negative terminal (positive terminal 12-volt systems) and generator commutator. Connect a jumper lead from the other battery post to the armature core or shaft as shown in Figure 10. Contact each commuter segment with the voltmeter lead. If voltage is indicated on the volt-

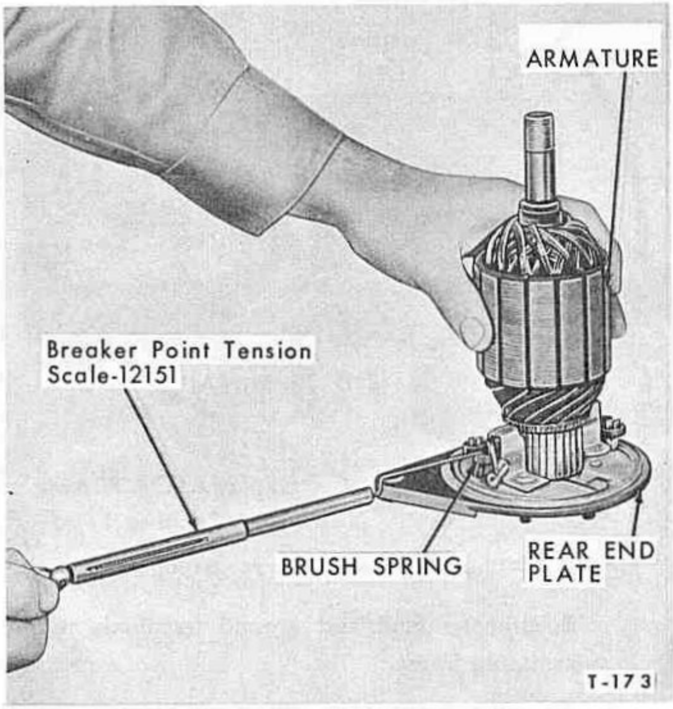


Figure 8—Checking Brush Spring Tension

meter, the armature is grounded and must be replaced.

Generator Field Coil Tests.

1. Check the field coils for an open circuit by attaching an ammeter between the generator field terminal and the battery negative post (positive post on 12-volt systems).

   NOTE: ***Use the proper voltage battery when making electrical tests.***

2. Connect another lead from the other battery post to the generator ground terminal as shown in Figure 11. The ammeter should register 1½-2 amperes. A higher current reading indicates a short circuit. If no current flows, the field has high resistance or an open circuit.
3. Check for a grounded circuit by connecting a jumper wire from the generator case to the battery positive post (negative post on 12-volt systems). Connect a voltmeter between the generator field terminal and the other battery post as shown in Figure 12. If a reading is indicated on the meter, the field coils are grounded and must be replaced.

G. Generator Repair

1. Check the commutator runout as shown in Figure 13. If the commutator surface is rough or more than 0.002 inch out of round, it should be turned in a lathe or with a turning tool as shown in Figure 14.

   Remove no more copper than necessary to clean up the commutator.

   After the commutator is turned down, undercut the mica between the bars ⅓₂ inch below the copper, using the undercutting tool as shown in Figure 15. Figure 16 illustrates samples of proper and improper undercutting. Polish the commutator with # 00 to # 000 sandpaper to remove all burrs. Brush away all particles of copper and mica insulation between the commutator segments. Recheck the armature in a growler.

2. To remove the field coils, remove the field and ground terminal screws from the armature frame. Remove the two pole screws as shown in Figure 17. The tool can be fabricated by electric welding a piece of $\frac{5}{16}$ inch square bar stock in a nut.

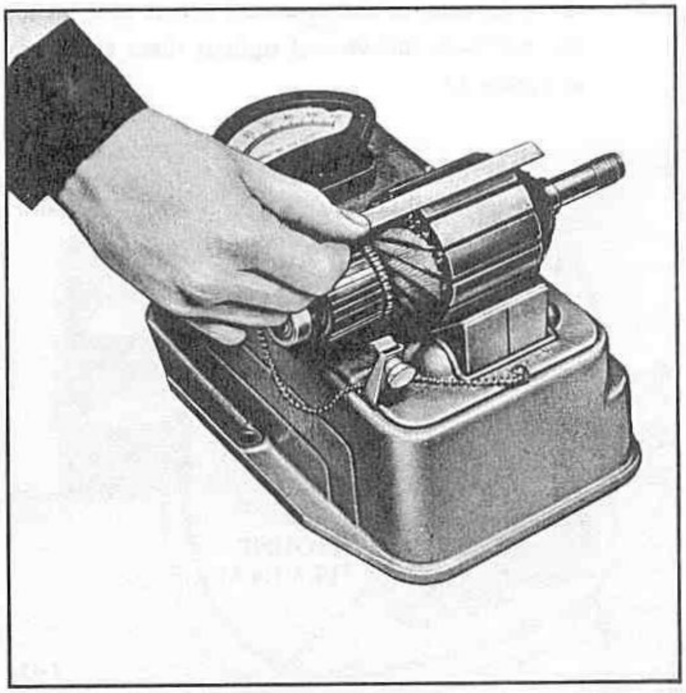


Figure 9—Checking Armature for Short Circuits Using a "Growler" Tester

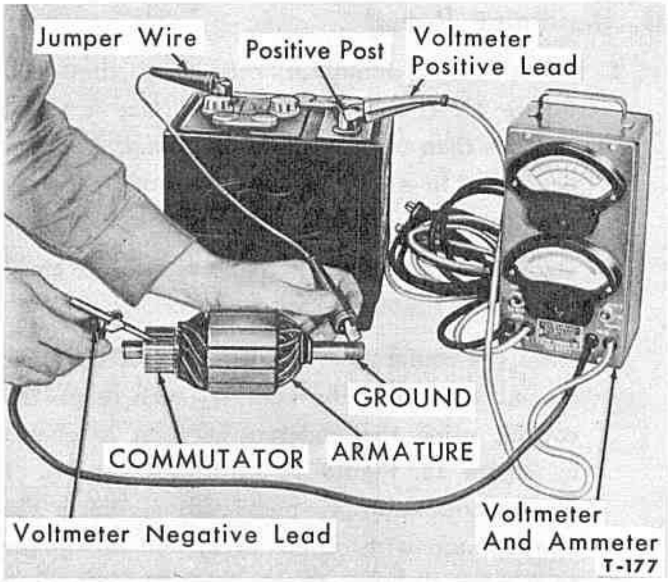


Figure 10—Checking Armature for Grounded Circuit

NOTE: ***Tighten the vise only enough to prevent the tool from slipping out of pole screw. Overtightening the vise may distort the armature frame.***

Slip the pole shoes and field coils out of the armature frame. Separate the pole shoes from the windings.

Position the pole shoes in the field coils. Place the field coils in the armature frame and install the two pole screws and tighten them as shown in Figure 17.

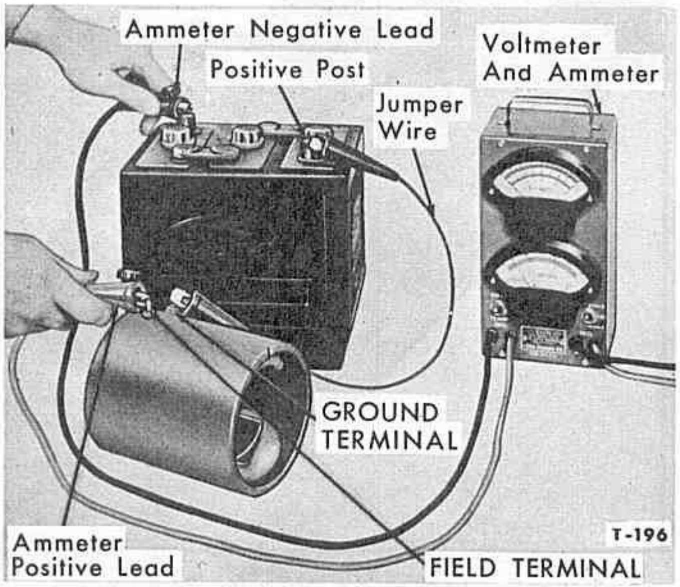


Figure 11—Checking Field Coils for Open or Short Circuit

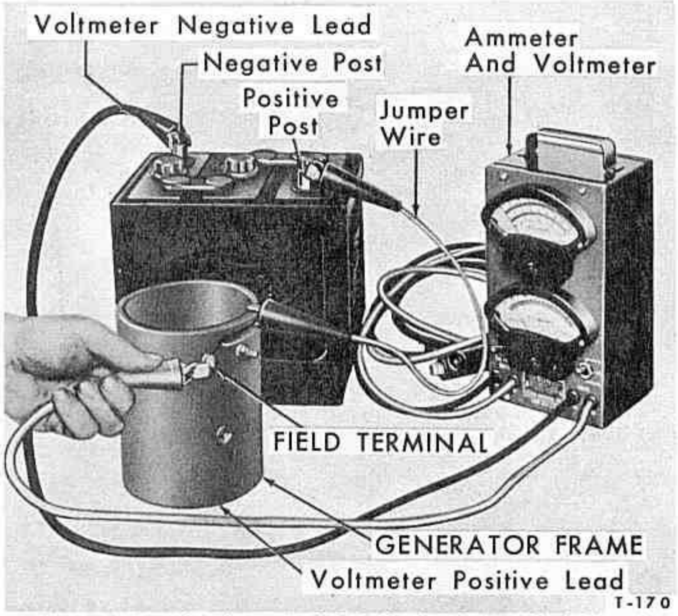


Figure 12—Checking Field Coils for Grounded Circuit

Secure the field and ground terminals to the armature frame.

3. To remove the rear end plate bearing, install the end plate in a vise equipped with brass jaws. Install FT-48 Puller Attachment 955-14 as shown in Figure 18. Pull the bearing from the end plate.

   Install the bearing in the end plate with a driver that fits the bearing as shown in Figure 19.

4. New brushes should be seated before assembling the generator. Lay a strip of #00 or #000 sandpaper, slightly wider than the width of the brush, over the commutator. Be sure the abrasive side is next to the brush. Position the brush

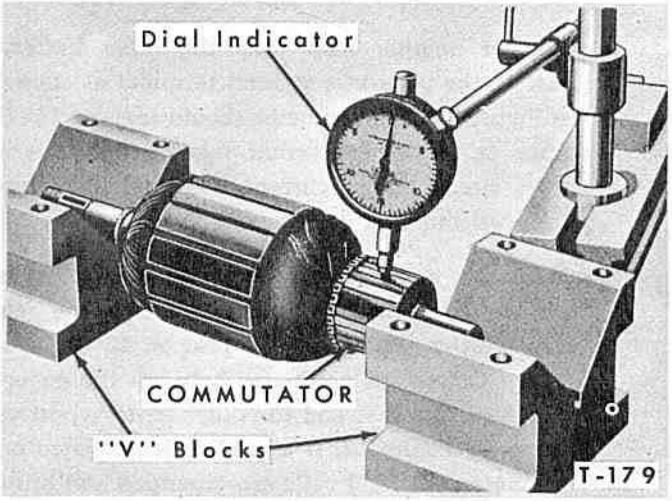


Figure 13—Checking Commutator Runout

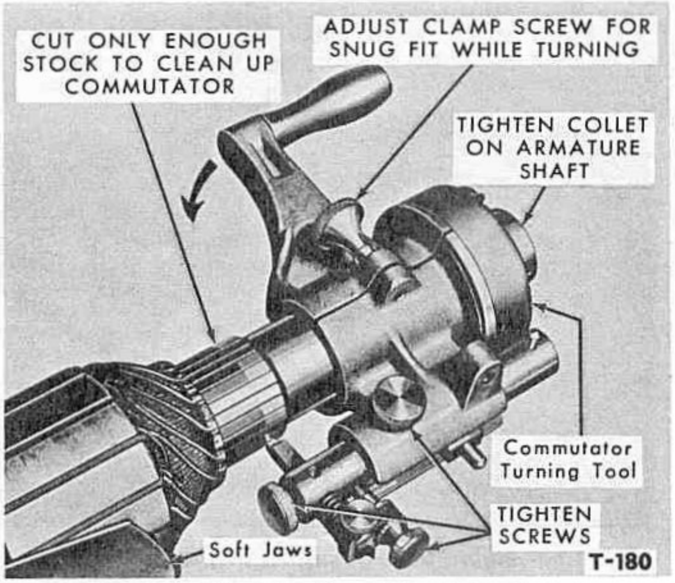

CUT ONLY ENOUGH STOCK TO CLEAN UP COMMUTATOR
ADJUST CLAMP SCREW FOR SNUG FIT WHILE TURNING
TIGHTEN COLLET ON ARMATURE SHAFT
Commutator Turning Tool
TIGHTEN SCREWS
Soft Jaws
T-180

Figure 14—Turning Armature Commutator

springs on the brushes, then pull the sandpaper from under the brush, Figure 20, until the brush conforms to the armature. After brushes are seated, blow the abrasive dust from the commutator with moisture free air.

H. Generator Assembly

1. Install the armature brush in the brush holder. Push the insulator through the hole from the external side of the end plate. Place the brush lead on the armature terminal. Secure the assembly by installing the flat washer and nut, Figure 7. Connect the other brush to the end plate with a screw and lockwasher.
2. Install the end plate assembly on the armature being careful not to chip the brushes.

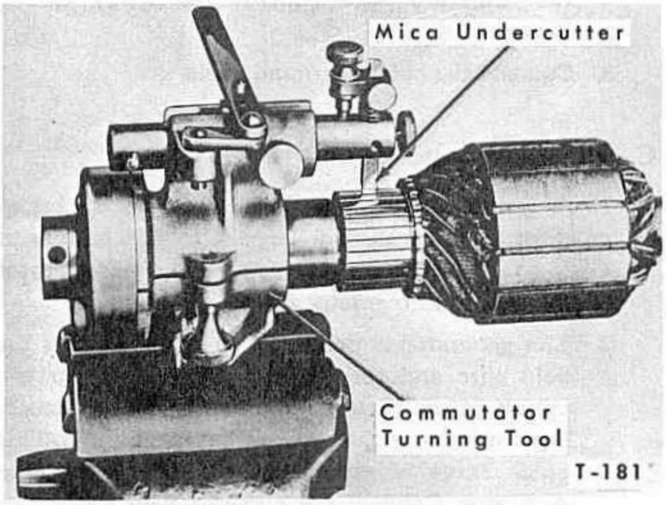


Figure 15—Undercutting Mica from Commutator

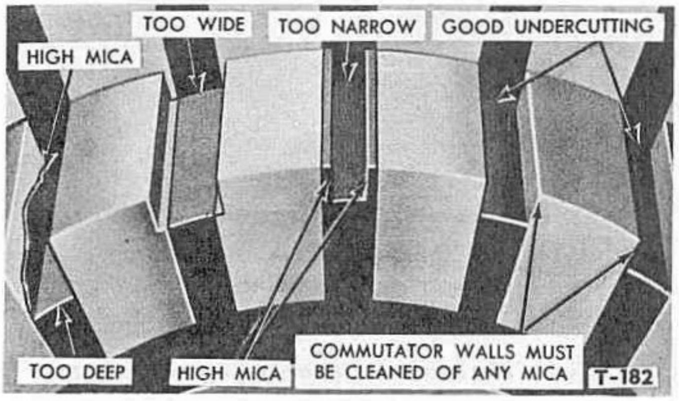


Figure 16—Examples of Proper and Improper Undercutting

3. Slip the armature into the rear of the armature frame and align the dowel in the rear end plate with the notch in the frame.
4. Carefully press the bearing into the front end plate and install the lock ring. Slip the front end plate onto the armature and align the dowel in the end plate with the notch in the frame.
5. Install the two generator through bolts.
6. Tap the woodruff key into the armature shaft and install the pulley. Secure the pulley with a nut and lockwasher.

GENERATOR REGULATOR

The generator regulator used on all series tractors, consists of two main control units. Namely, the volt-

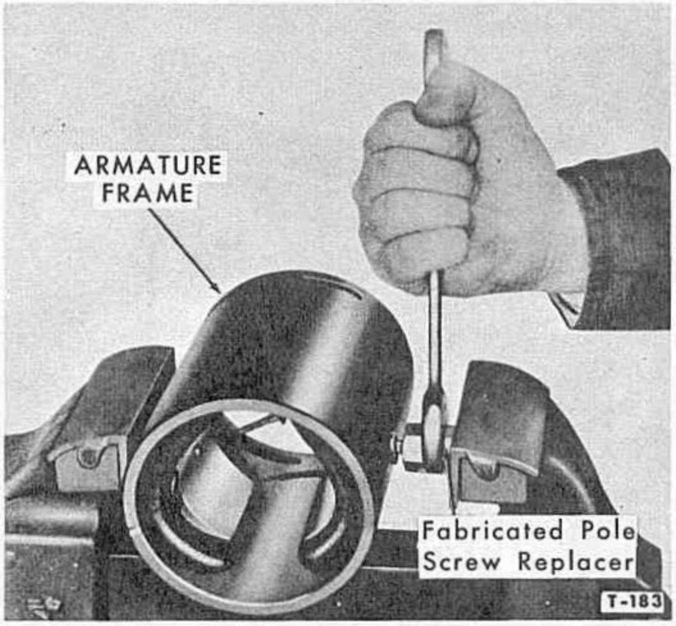


Figure 17—Removing Pole Screw

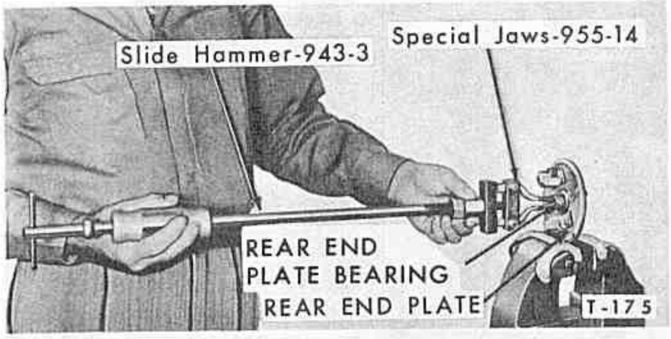


Figure 18—Removing Rear End Plate Bearing

age limiter relay and the cutout relay, mounted as an assembly, inside the sealed case. Current control is obtained by winding three turns of the series winding around the voltage limiter coil. This arrangement restricts the generator current output to a maximum of 20 amperes.

The cutout relay serves as an automatic switch, which connects the generator to the battery when the generator voltage reaches the value for which the output is calibrated.

The voltage limiter holds the generator voltage at a pre-determined value. The voltage limiter and cutout relay are temperature compensated. This causes the regulator voltage to vary with changes in temperature.

The electrical tests for checking voltage regulator operation are performed in the generator section.

A. Generator Regulator Removal

1. Disconnect the battery ground cable.

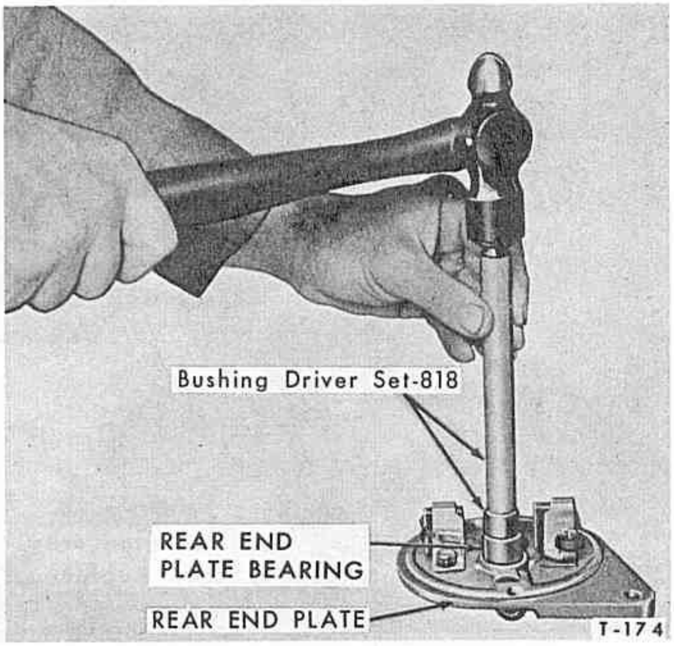


Figure 19—Installing Rear End Plate Bearing

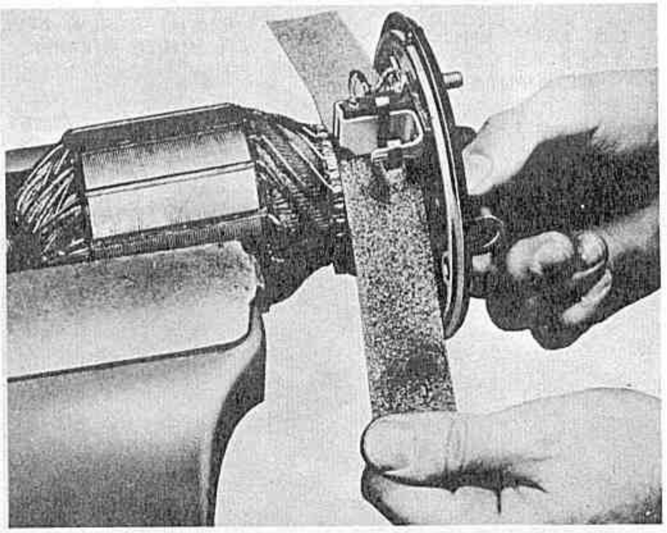


Figure 20—Seating New Brushes

2. Working through the hood top center panel, disconnect the battery wire, (heavy yellow wire) field wire, (light yellow wire) and the armature wire, (double red wire), from the posts on the regulator.
3. Remove the three regulator attaching screws and generator ground wire (black wire).
4. Remove the generator regulator.

B. Generator Regulator Installation

1. Hold the generator regulator in position on the steering gear and install the three attaching screws and ground wire (black wire).
2. Connect the battery wire (heavy yellow wire) to the top terminal. Connect the field wire (light yellow wire) to the center terminal. Connect the armature wire (double red wire) to the lower terminal.
3. Connect the battery ground cable.

C. Polarizing the Generator

1. A generator that has been repaired or tested must be polarized in respect to the battery it is to charge. Failure to polarize the generator may result in regulator failure.
2. The generator is polarized by disconnecting the field wire and the battery wire from their terminals at the regulator, and momentarily touching the two together. (Engine not running). This quick surge of current correctly polarizes the generator. Connect the wires to their respective terminals on the regulator.

3. STARTING MOTOR, SOLENOID AND STARTING CIRCUIT

The starting system includes the starting motor and drive assembly, starter switch, (safety control switch with Select-O-Speed transmission), starting motor relay, battery and the necessary wiring and cables. The starting system is six-volts on all gasoline and LP-Gas model tractors and twelve-volts on all diesel models. The differences in the starting motors are the field coils, brushes and the drive assemblies.

STARTING MOTOR

A. Removal

1. Diesel Engine: Remove the air cleaner tube and air cleaner.
2. Remove the oil filter from the cylinder block.
3. Disconnect the starting motor cable from the terminal on the starting motor.
4. Remove the three bolts and lockwashers that attach the starting motor to the engine.

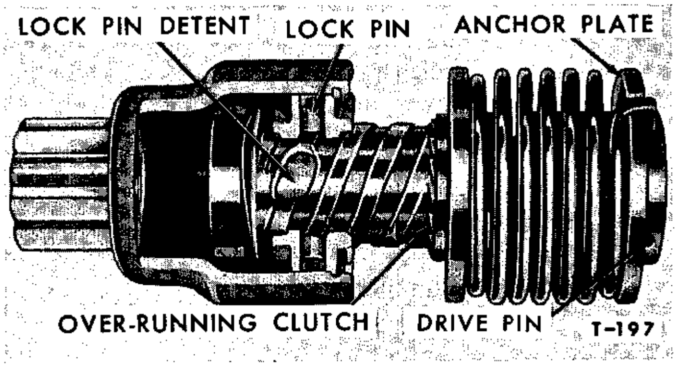


Figure 21—Starting Motor Drive

5. Lift the starting motor from the engine.

B. Disassembly

In many cases it will not be necessary to completely disassemble the starting motor to accomplish the repair or replacement of certain parts.

1. Compress the anchor plate, then remove the drive pin from the starter drive, Figure 21.

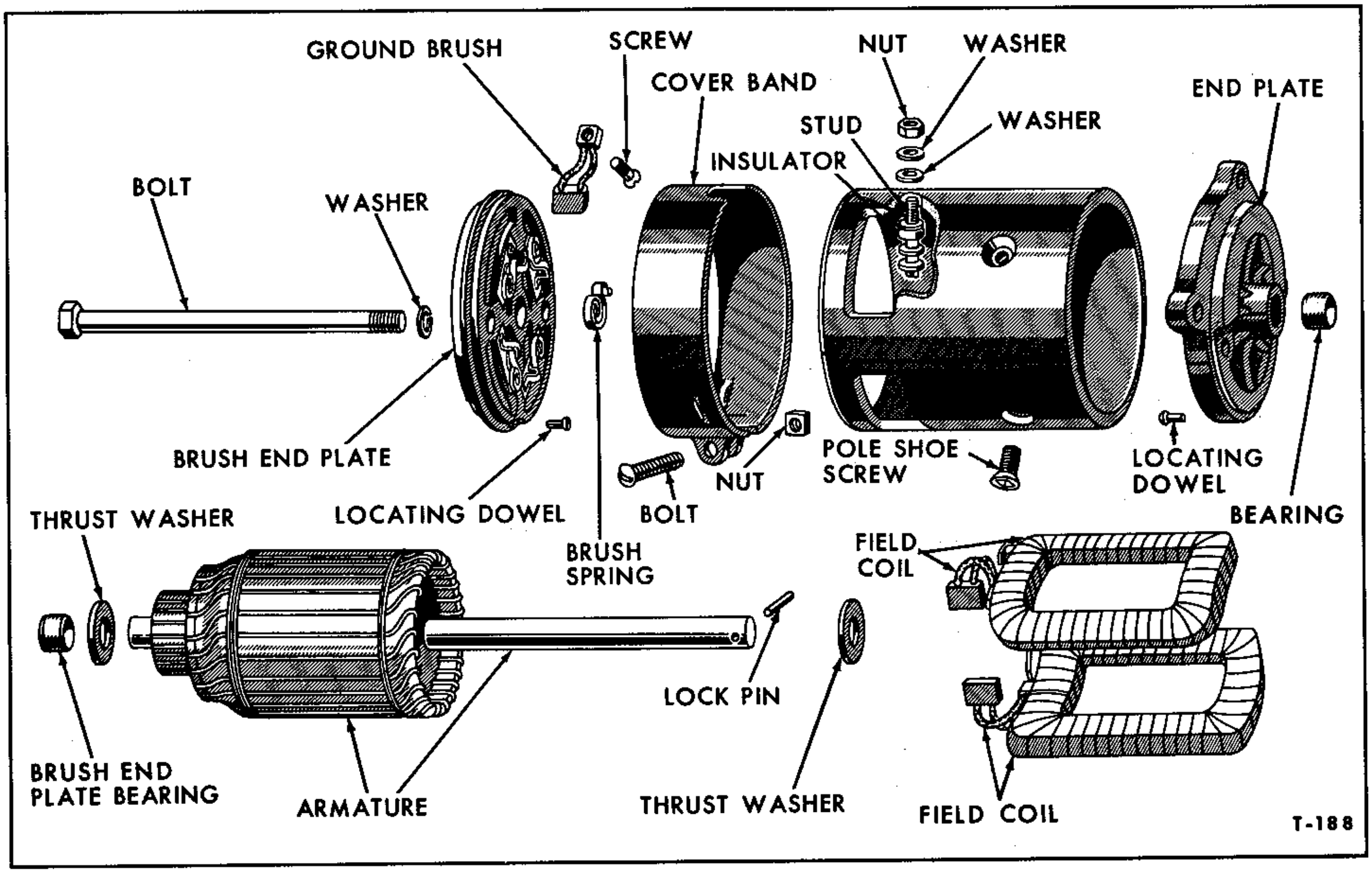


Figure 22—Starting Motor Disassembled

2. Remove the cover band from the armature frame.

3. Remove the two through bolts from the rear end plate, then remove the front end plate and armature from the frame, Figure 22. Slip the front end plate off the armature shaft.

4. Remove the two screws that attach the ground brushes to the frame. Disengage the brushes from the brush holders then remove the brush end plate from the frame.

C. Inspection

Visual Checks:

1. Replace brushes if worn to less than 5⁄16" in length, broken or if the leads are frayed or damaged.

2. Inspect the armature for a bent shaft or a rough commutator. Replace the armature if the shaft is bent. A rough commutator can be turned in a lathe or with a turning tool as shown in Figure 14.

   NOTE: ***Do not undercut the mica on a starting motor armature.***

3. Place the end plates in their respective positions on the armature shaft. If any looseness is noted, replace the bearings.

4. Inspect the starting motor drive, see Figure 21, for burrs, broken or worn teeth. Check the action of the pinion on the worm. It should slide freely on the threads. Check the drive spring to see if it is cracked, broken, or if the end tangs are bent. Check the anchor plate for cracks or damage. Replace the starting motor drive unit if any of these conditions are evident.

5. Replace the terminal on the frame if broken, worn or stripped.

Electrical Tests:

1. Connect a voltmeter lead and a battery lead to the frame and contact the other voltmeter lead to each brush as shown in Figure 23. If no reading is obtained on the voltmeter, the field circuit is open and the field coils must be replaced. Connect the voltmeter and battery as shown in Figure 24. If the voltmeter shows any voltage, the field coils are grounded and must be replaced.

2. Connect a voltmeter and battery to the armature as shown in Figure 25. If a reading is obtained on the voltmeter, the armature windings are grounded and the armature must be replaced. A burned segment on the commutator indicates an open circuit making it necessary to replace the armature. Each segment of the commutator must be checked.

D. Repair

1. Remove the bearing from the brush end plate as shown in Figure 26 with Clutch Pilot Bearing Remover 7600-E.

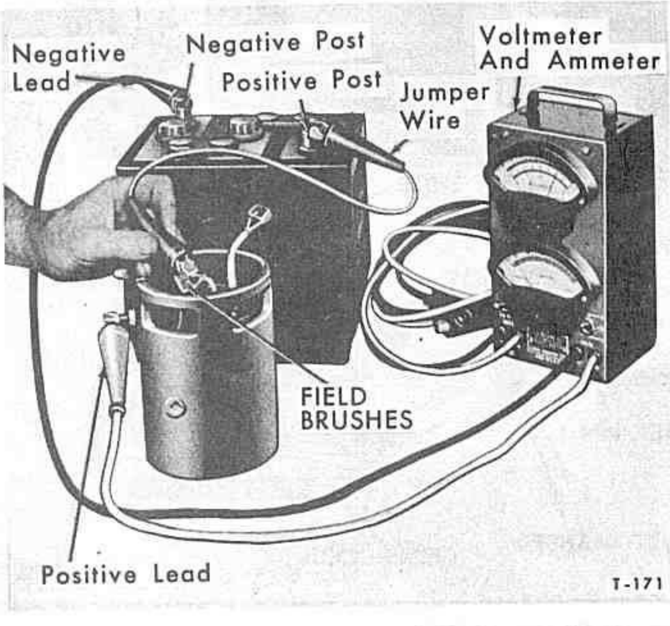


Figure 23—Checking Field Coils for Open Circuit

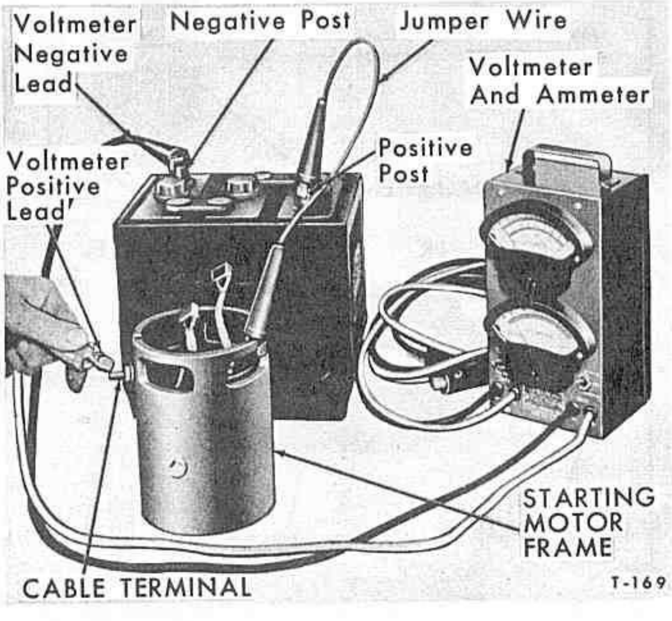


Figure 24—Checking Field Coils for Grounded Circuit

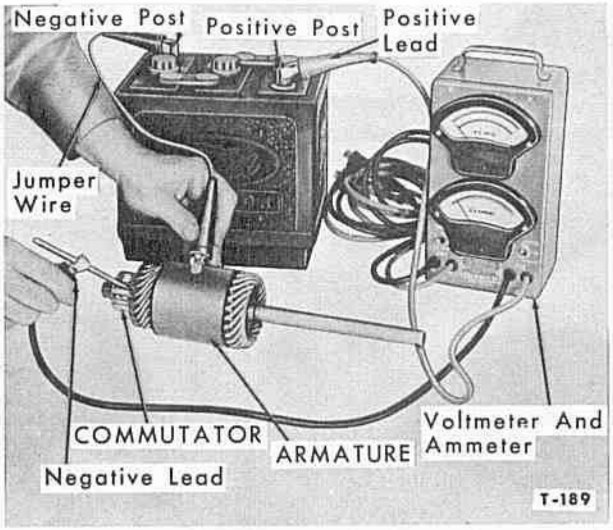


Figure 25—Checking Armature for Grounded Circuit

Install the bearing in the end plate as shown in Figure 27, with Bushing Driver Set–818. Drive the bearing 1/16-1/8 inch below the thrust washer surface.

2. Remove the bearing from the front end plate with Bushing Driver Set–818 as shown in Figure 28.

   Drive the bearing into the front end plate with Bushing Driver Set–818 as shown in Figure 29 until it is flush with the outer surface of the plate.

3. Unsolder the field coil shunts from the terminal stud. Remove the pole screws that attach the pole shoes and field coils to the frame as shown in Figure 17.

   NOTE: ***On six-volt starting motors, remove only the two pole shoes that retain the field coils.***

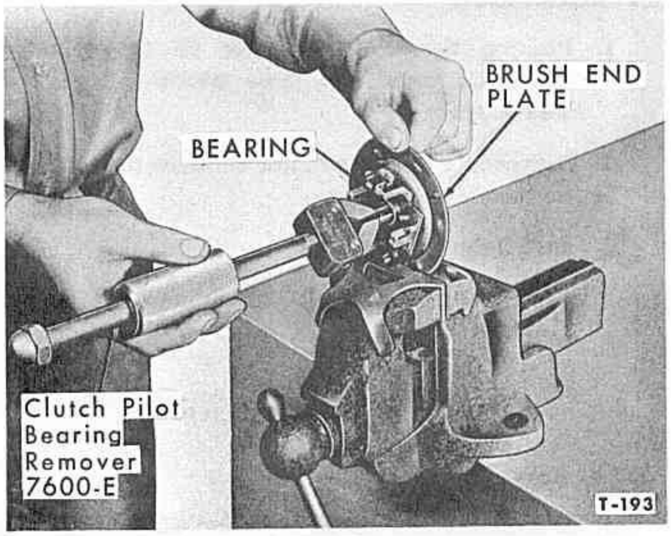


Figure 26—Removing Brush End Plate Bearing

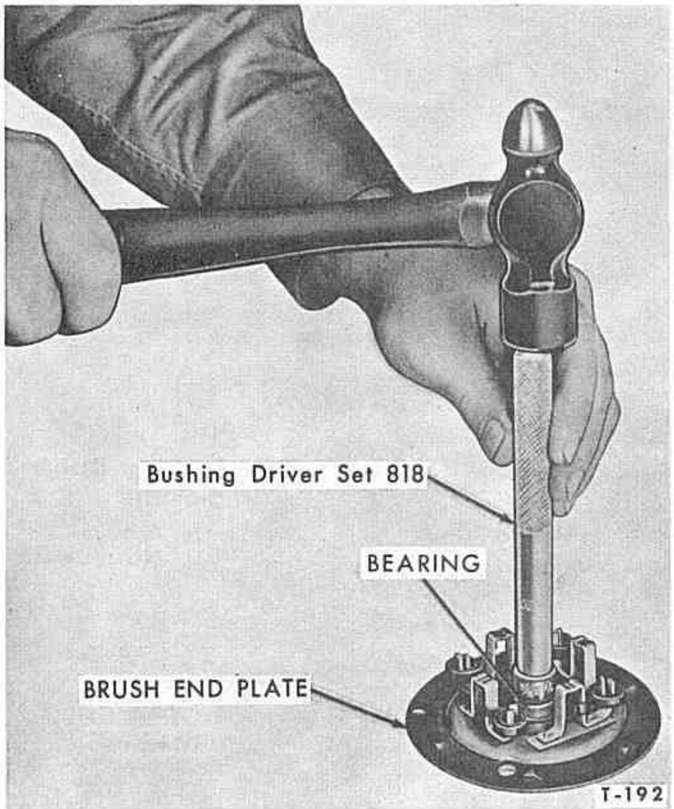


Figure 27—Installing Bearing in Brush End Plate

The tools used in Figure 17, can be fabricated by electric welding a 5/16 x 1 inch piece of square bar stock to a nut.

NOTE: ***Tighten the vise only enough to prevent the tool from slipping out of the pole screw. Overtightening the vise may distort the starting motor frame.***

Remove the field coils and pole shoes from the armature frame.

4. To install the field coils, position the field coils and pole shoes in the armature frame with the field coil shunts in the terminal stud. Install and tighten the pole shoe screws with the fabricated tool. Strike the frame with a plastic hammer to seat the coils then retighten the screws.

   NOTE: ***Six-volt starting motors have only two field coils while the twelve-volt have four.***

5. Solder the field coil shunts to the terminal stud.

6. To remove the field coil brushes, unsolder the brush leads from the shunts. Six-volt starting motors have the insulated brushes connected to separate shunts while the twelve-volt motors will have both insulated brushes connected to one shunt.

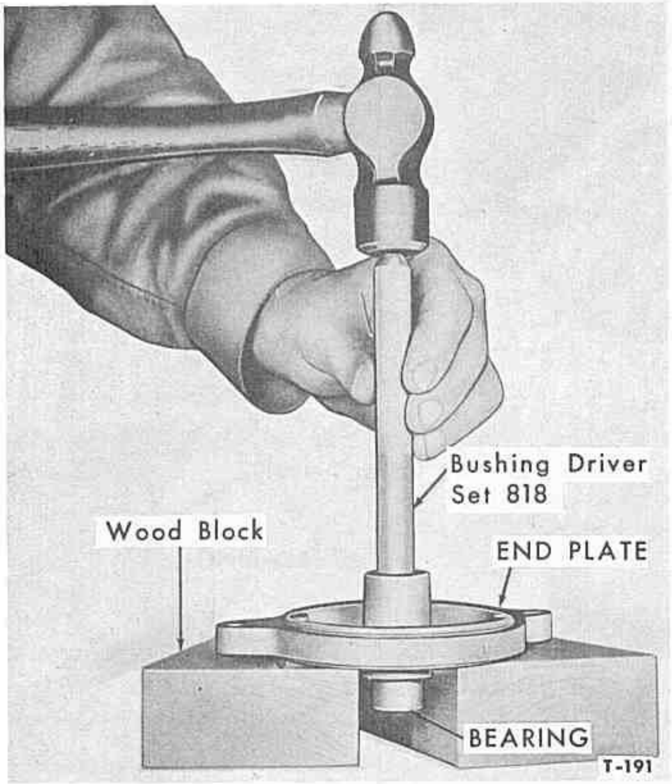


Figure 28—Removing Bearing from Front End Plate

7. Clean the shunt or shunts thoroughly then solder the brush leads in place. Before soldering twelve-volt brushes, secure the brush leads to the shunt with the clip provided. Flow solder between the clip, brush leads, and shunt. On twelve-volt motors, the brush with the shortest lead must be toward the terminal stud.

   IMPORTANT: ***Use only resin core solder.***

E. Assembly

1. Install the two ground brushes in the holders with the springs on the side of the brushes to hold them in place, Figure 30. Align the detent in the brush end plate with the notch in the frame, then install the field (insulated) brushes in their holders in the same manner. Use a wire hook to lift the brushes while installing them in the holders.

2. Place a thrust washer on each end of the armature. Slip the front end plate on the armature shaft.

3. Install the armature and front end plate on the frame. Align the dowel in the front end plate with the notch in the frame, install the two through bolts and washers.

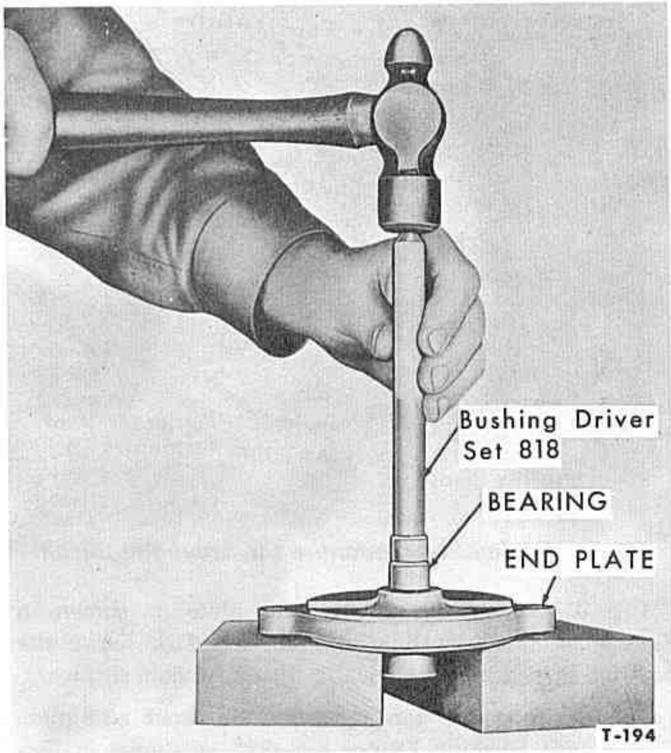


Figure 29—Installing Bearing in Front End Plate

4. Press the brushes down with a small punch to release the springs and seat them on the commutator as shown in Figure 31. Install the cover band on the frame.

5. Slip the starting motor drive on the armature shaft compress the anchor plate, Figure 21, then install the drive pin through the drive and armature shaft.

F. Installation

1. Position the starting motor on the cylinder block and install the three attaching bolts and lock washers.

2. Connect the starting motor cable to the terminal on the armature frame.

3. Install the oil filter.

4. Diesel Engine: Install the air cleaner and air cleaner tube.

STARTING MOTOR RELAY

A. Removal

1. Disconnect the battery ground cable from the right side of the tractor.

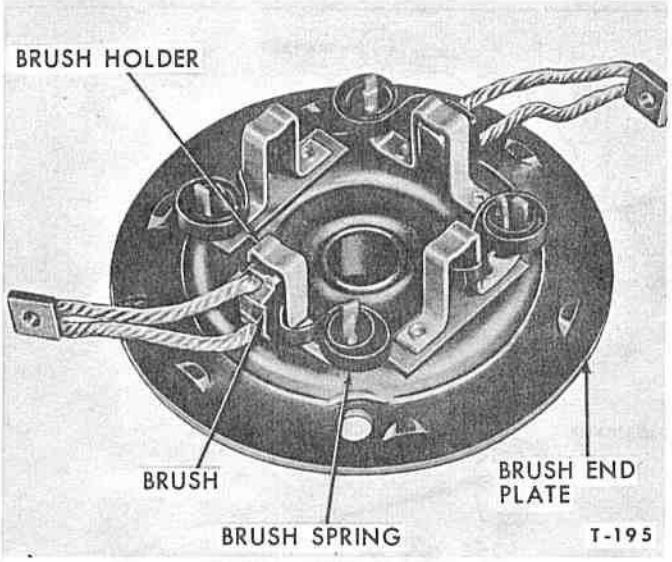


Figure 30—Installing Brushes in End Plate

2. Remove the air cleaner tube.
3. Disconnect the cables and attaching wires from the relay.
4. Remove the nuts and washers that attach the relay to the tractor and remove the relay.

B. Installation

1. Secure the relay to the tractor with two nuts and lockwashers.
2. Connect the two cables and wires to their respective terminals on the relay.
3. Connect the battery ground cable to the right side of the tractor.

STARTER SWITCH

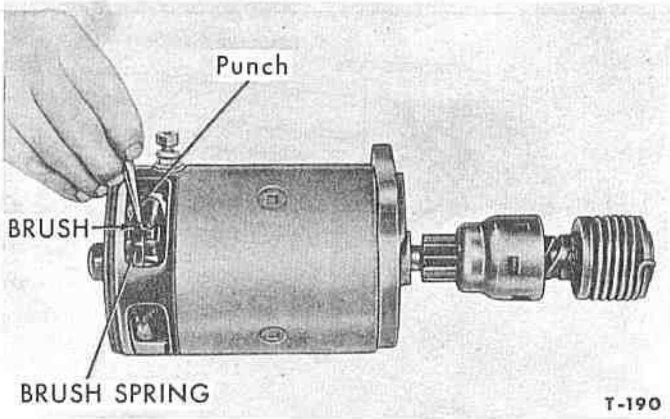


Figure 31—Releasing Brush Springs

Replacement of the transmission mounted starter switch and the safety control switch (Select-O-Speed) will be covered in the Transmission Section of this manual. The replacement of the starter switch mounted on the lower hood panel on the Select-O-Speed models, is detailed below.

A. Removal

1. Open the hood top panel and disconnect the two wires from the switch.
2. Remove the knurled nut from the underside of the hood.
3. Reach through the hood opening and remove the switch.

B. Installation

1. Position the starter switch in the hood panel and install the knurled attaching nut.
2. Connect the two wires to the two switch terminals.

4. LAMPS AND LIGHTING CIRCUIT

Head lamps can be disconnected from the circuit at the bullet connectors shown in Figures 32 and 33. After disconnecting the wire, remove the light retaining nut, lock washer and bracket, and remove the light. Sealed beams are replaced by removing the bolts at the bottom of the retaining ring. Taillights are also replaced by removing and installing parts in the sequence shown in Figures 32 and 33.

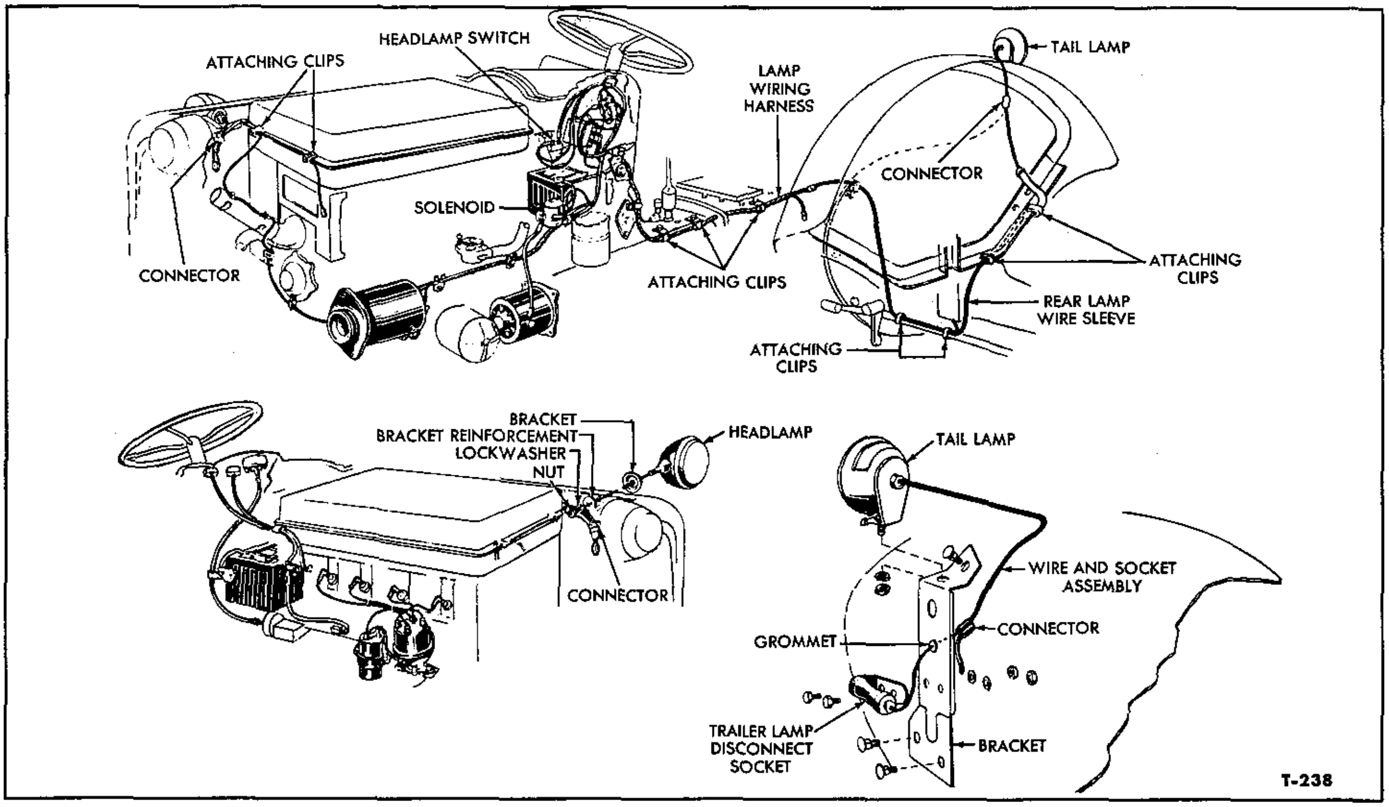


Figure 32—Lamp Circuit 1955-1957 Models

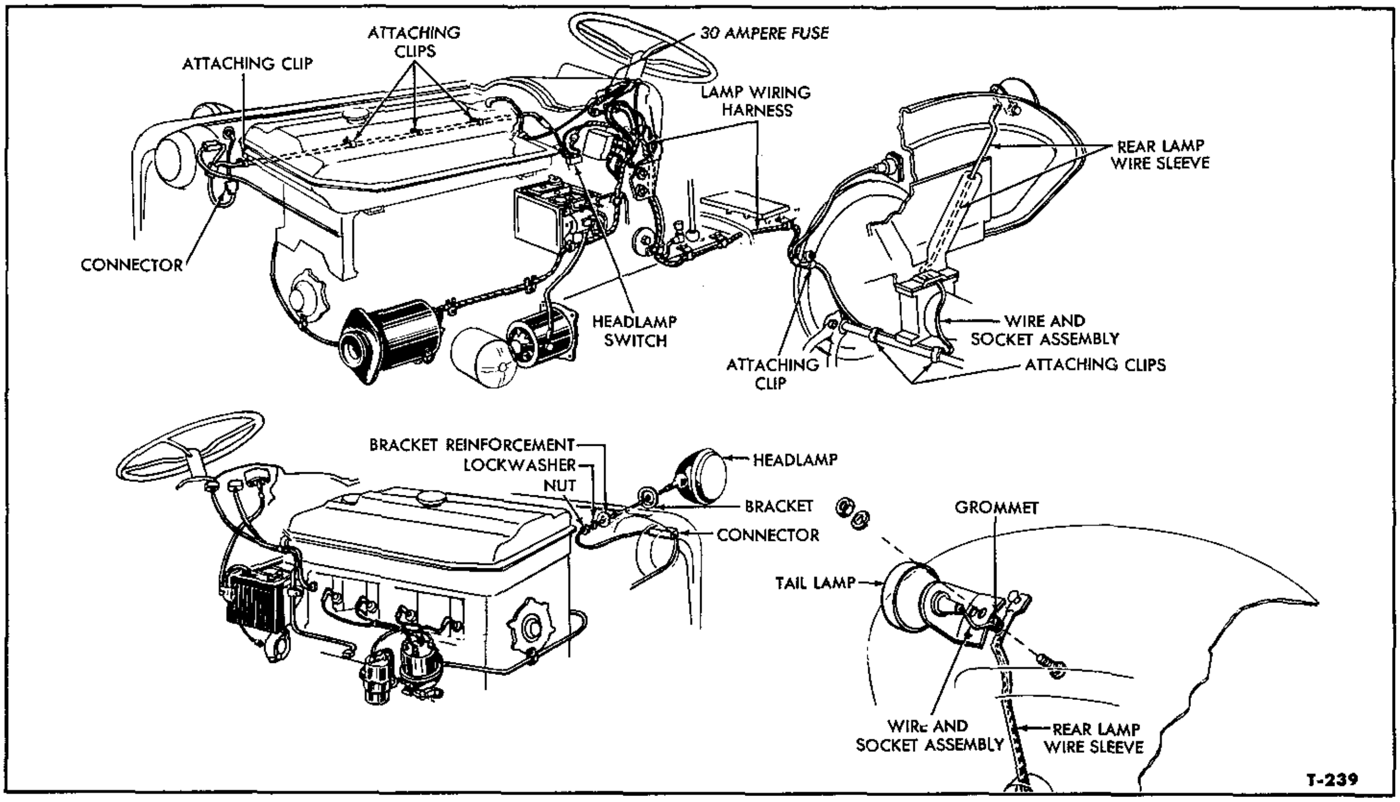


Figure 33—Lamp Circuit 1958-1959 Models

5. MANIFOLD HEATERS, RELAY AND ELECTRICAL CIRCUIT—DIESEL

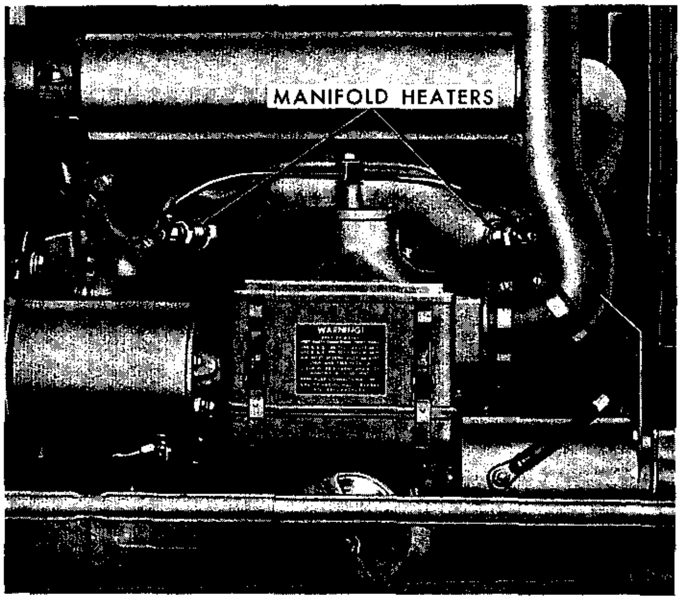


Figure 34—Manifold Heaters Installed

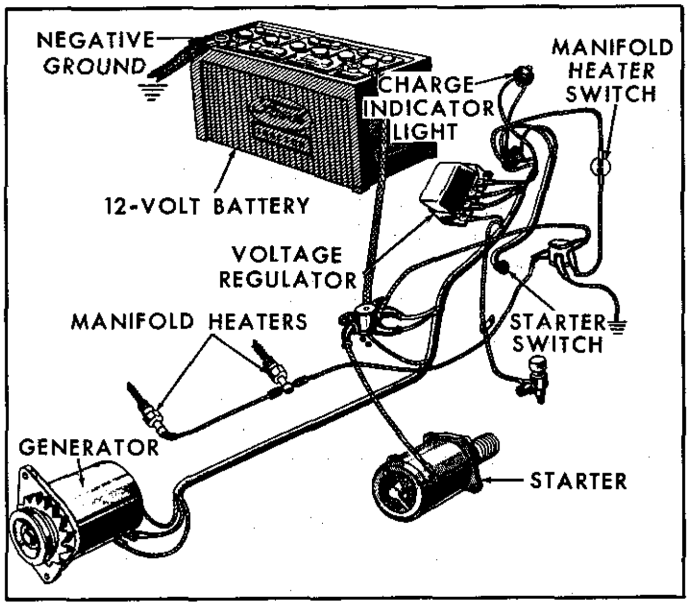


Figure 35—Manifold Heater Electrical Circuit

Manifold heaters, Figure 34, are provided on diesel engines to assist in starting the engine in cold weather. The heaters have a heating element on the inner end to heat the air before it enters the combustion chamber.

The heaters are actuated by a switch relay and the necessary wiring as shown in Figure 35.

A. Manifold Heater Replacement

1. To replace the manifold heaters, disconnect the wire at each heater.
2. Turn the heater counterclockwise out of the intake manifold.
3. To install the manifold heaters, place a new gasket on each heater base.
4. Thread the manifold heater into the intake manifold and tighten them.

B. Relay Replacement

1. To replace the manifold heater relay, disconnect the battery ground cable from the right side of the tractor.
2. Open the hood and disconnect the four wires from the manifold heater relay, Figure 35.
3. Remove the two bolts, nuts and lockwashers that attach the relay to the inner side of the left hood panel.
4. To install the relay, hold it in place on the inside of the left hood panel and install the two attaching bolts, nuts and lockwashers.
5. Connect the four wires to their respective terminals on the relay.
6. Connect the battery ground cable to the right side of the tractor.

C. Switch Replacement

1. To replace the manifold heater switch, open the hood top panel and disconnect the two wires from the switch terminals.
2. Working from the underside to the rear of the left hood side panel, remove the knurled nut that attaches the switch to the hood.
3. Remove the switch through the top panel.
4. To install the switch, position it in the panel and secure in place with the knurled nut.
5. Connect the two wires to the switch terminal.

6. TROUBLE SHOOTING

Trouble shooting or diagnosis is required before actual repairs are made in the electrical system. Even where an obvious fault makes the replacement of a unit necessary, the cause of the unit failure must be determined. The trouble shooting procedures given here will aid you in making a correct diagnosis. When the trouble is diagnosed correctly, unnecessary repairs are prevented, the time the tractor is out of service will be decreased, and the repairs that are made will be effective.

GENERATING SYSTEM

All the various causes of troubles in the generating system, can be attributed to three conditions. The conditions or symptoms may not be described correctly to you by the owner of the tractor, so you must first determine the correct symptom by testing or by analizing the indications given to you by the owner. Once you have confirmed the symptom, you can immediately begin to isolate the cause by following the road map that illustrates the procedure in outline form.

Table I lists the three symptoms and the various causes of trouble. The order of the number in each symptom column indicates either the most probable cause of the symptom or the cause which is easiest to eliminate by testing.

The trouble shooting table gives more detailed information on the various causes of the symptom than the road map, Figure 36. The road map of the particular symptom groups several of those details into a single test, however, the results of the test indicate which particular trouble is the one causing the symptoms.

The symptoms are used as headings for the procedure and have been arranged in the following order: "A. Battery Low in Charge," "B. Generator Output Low," and "C. High Charging Rate."

CAUSES	SYMPTOMS (1) Battery Low In Charge See Page 76	(2) Generator Out-Put Low See Page 78	(3) High Charging Rate See Page 78
Excessive Resistance in Battery to Ground Circuit	19	1	
Dirty Commutator	3	2	
Open Circuit Field	4	3	
Short Circuit Field	5	4	
Open Circuit Armature	6	5	
Short Circuit Armature	7	6	
Shorted Brush Holder	8	9	
Worn Generator Brushes	9	7	
Brushes Stuck in Holder	10	8	
Regulator Contacts Stuck	12		1
Loose or Worn Generator Belt	1		
Battery Worn Out	2		
Burned or Corroded Regulator Contacts	11		
Cut-In Voltage High	13		
Cut-In Voltage Low	14		
Voltage Regulation High			2
Voltage Regulation Low	15		
Regulator Not Grounded	16		
Burned or Corroded Cut-Out Contacts	17		
Excessive Resistance in Armature-to-Battery Circuit	18		

Table 1—Generating System—Causes of Trouble

A. Battery Low in Charge

Slow cranking, hard starting, and headlights dim at engine idle speed indicate the battery may be low in charge. This could be caused by the generator belt being worn or loose and slipping over the generator pulley. The battery may be in such poor condition it will not hold or take a charge. The generator may not be producing its rated output. Regulator units may be out of adjustment. Excessive resistance may exist in the generator-to-battery circuit or in the battery-to-ground circuit.

Before starting the following procedure to confirm the symptom, check the state of charge of the battery. Also check the generator belt adjustment and wiring. If the belt is too loose, this might be the only trouble.

1. Recharge the battery to make a high rate discharge test. Replace the battery if the high rate discharge test indicates it is worn out or under capacity. If the battery is worn out, it may have been the cause of the "Battery Low" symptom. If the battery tests OK, proceed as follows:

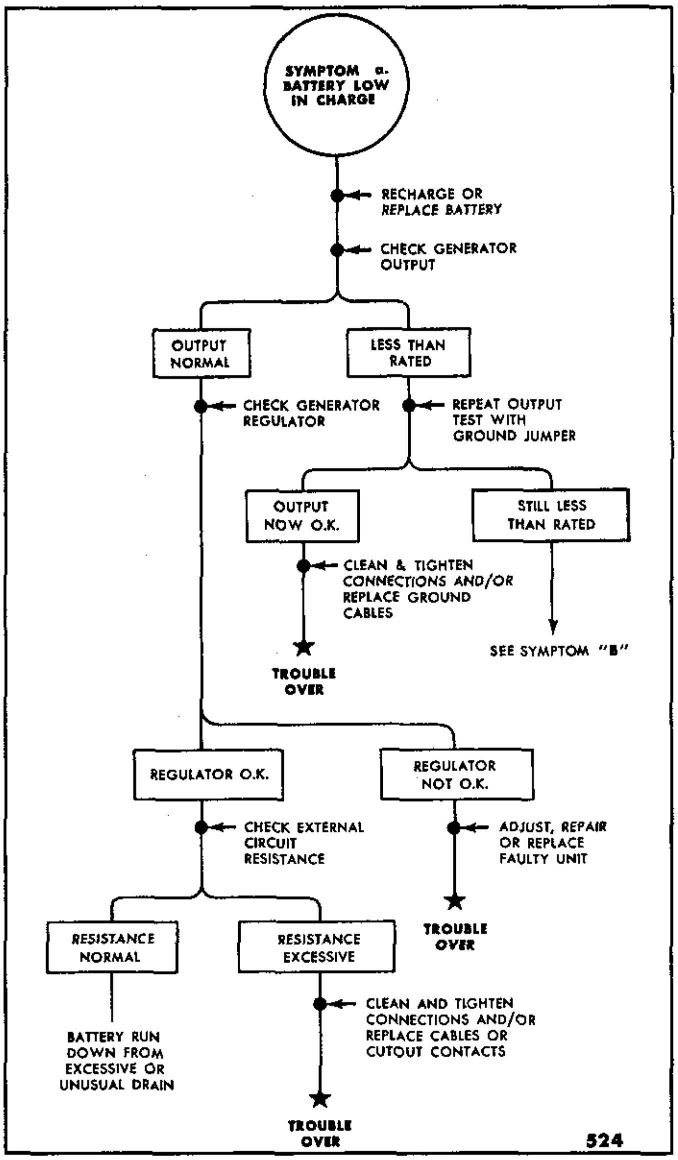

SYMPTOM a. BATTERY LOW IN CHARGE
RECHARGE OR REPLACE BATTERY
CHECK GENERATOR OUTPUT
OUTPUT NORMAL
LESS THAN RATED
CHECK GENERATOR REGULATOR
REPEAT OUTPUT TEST WITH GROUND JUMPER
OUTPUT NOW O.K.
STILL LESS THAN RATED
CLEAN & TIGHTEN CONNECTIONS AND/OR REPLACE GROUND CABLES
TROUBLE OVER
SEE SYMPTOM "B"
REGULATOR O.K.
REGULATOR NOT O.K.
CHECK EXTERNAL CIRCUIT RESISTANCE
ADJUST, REPAIR OR REPLACE FAULTY UNIT
TROUBLE OVER
RESISTANCE NORMAL
RESISTANCE EXCESSIVE
CLEAN AND TIGHTEN CONNECTIONS AND/OR REPLACE CABLES OR CUTOUT CONTACTS
BATTERY RUN DOWN FROM EXCESSIVE OR UNUSUAL DRAIN
TROUBLE OVER
524

Figure 36—Battery Low in Charge—Road Map

2. If the output reaches or is greater than the rating, proceed with b. below. If the output is less than the rated amperes, follow the procedure outlined in a. below.
   a. If the current output of the generator does not reach the rated output, connect a heavy jumper wire from the battery ground terminal to the generator ground terminal. Repeat the generator output test. If the output is still less than rated, the generator is at fault. Refer to "B. Generator Output Low." If the generator output now reaches or exceeds the rated output, the generator or the battery is not properly grounded to the engine. Remove the generator from its mounting bracket and scrape or sand the paint or dirt from the inner surface of the bracket strap and the corresponding surface of the generator. Remove the mounting bracket from the engine and scrape or sand the paint and dirt from the bracket-to-engine mating surfaces. Install the bracket and generator and adjust the generator belt. Replace the battery-to-ground cable if it is corroded or partially broken. Clean the generator ground wire connections at the generator and voltage regulator.
   b. If the generator output is normal, test the regulator to determine if it is properly adjusted. If any of the regulator units are improperly adjusted, replace the regulator. If the generator checks OK, check the external circuits to determine if they have excessive resistance. If high resistance is noted, follow the procedure (1) below. If the resistance is normal, proceed as follows:
      (1) If the resistance (voltage drop) is high, locate the exact part of the circuit with the excessive resistance and follow (2), (3), (4), and (5) below:
      (2) If the resistance is in the generator-to-regulator circuit, clean and tighten the cable connections. Recheck the voltage drop. If it is still excessive, replace the cable.

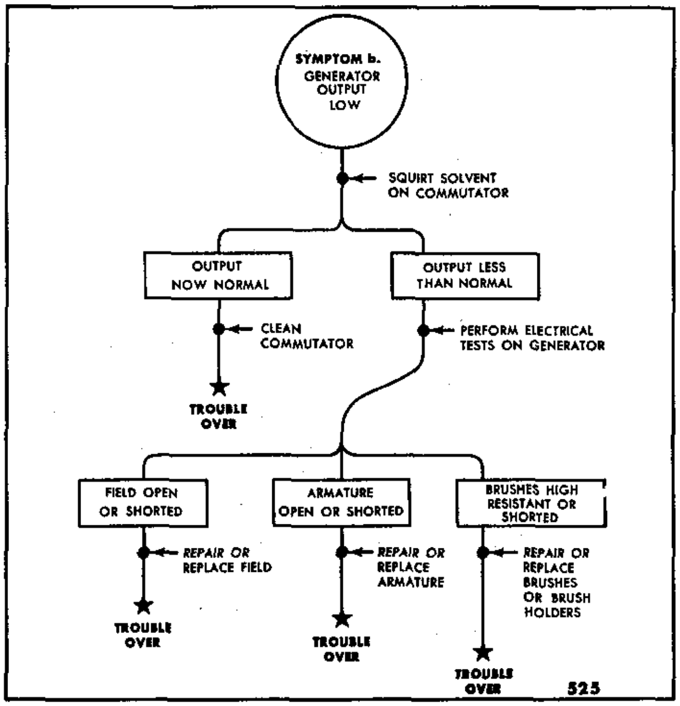

SYMPTOM b. GENERATOR OUTPUT LOW
SQUIRT SOLVENT ON COMMUTATOR
OUTPUT NOW NORMAL
OUTPUT LESS THAN NORMAL
CLEAN COMMUTATOR
PERFORM ELECTRICAL TESTS ON GENERATOR
TROUBLE OVER
FIELD OPEN OR SHORTED
ARMATURE OPEN OR SHORTED
BRUSHES HIGH RESISTANT OR SHORTED
REPAIR OR REPLACE FIELD
REPAIR OR REPLACE ARMATURE
REPAIR OR REPLACE BRUSHES OR BRUSH HOLDERS
TROUBLE OVER
TROUBLE OVER
TROUBLE OVER
525

Figure 37—Generator Output Low—Road Map

(3) If the resistance is in the regulator, or the cut-out contact, replace the regulator.

(4) If the resistance is in the regulator-to-battery circuit, clean and tighten the cable connections (regulator "BAT" terminal, battery terminal of starting relay, battery-to-starting-relay-cable connection on battery post.) Examine all cables to see that they are in good condition. Replace where necessary.

NOTE: ***Most of the trouble caused by excessive resistance in the external circuit will be found in this portion of the circuit.***

(5) If the resistance is in the battery-to-ground circuit, clean and tighten all cable connections. If voltage drop is still excessive, replace the cable.

B. Generator Output Low

The generator output could be low due to a dirty commutator, an open or short circuit in the field, armature, brushes, or brush holders. The brushes can be worn too short or not making good contact on the commutator or stuck in the holders. Figure 37 illustrates the "Generator Output Low" Road Map.

1. Remove the rear bearing and brush plate and squirt carbon tetrachloride on the commutator to determine if it is oily or dirty.

NOTE: ***Some generators do not have ventilator slots, therefore, they must be disassembled to clean or check the commutator.***

If dirt or oil is present, the carbon tetrachloride will momentarily dissolve the dirt or oil on the commutator and permit the brushes to make electrical contact.

If the generator output now tests normal, proceed with a. If the output is less than rated, proceed with b.

a. If the output now reaches rated amperes, the commutator is oily or dirty. Remove the generator from the tractor and disassemble it. Clean the commutator surface with #00 sandpaper (not emery cloth or emery paper) and scrape out the slots between the commutator segments to remove dirt and carbon particles. If necessary, turn down the commutator in a lathe and undercut the mica. Reassemble the generator and install it. Adjust the generator belt tension.

b. If the output is still less than normal, perform the electrical tests on the generator on the tractor as necessary to determine the exact part of the generator causing trouble. If the field checks short or open, follow (1). If the armature checks short or open, follow (2). If the brushes are making poor contact or are shorted, follow (3).

(1) If the test shows the field has an open or short circuit, remove the generator, disassemble it and repair the condition, if possible. If no repairs can be made, replace the field coils and reassemble the generator. Mount the generator on the engine and adjust the generator belt tension.

(2) If the armature test shows the armature circuit to have an open or short, remove the generator, disassemble it and repair the condition, if possible. If the repair cannot be made, install a new armature and reassemble the generator. Mount the generator and adjust the generator belt tension.

(3) If the brush test shows the brushes are making poor contact or are shorted to the end plate, the frame, or the field coil leads, remove the generator, disassemble it and repair the condition, if possible. If the brushes are stuck in the holder, repair or replace the end plate and brushes. Replace the brushes if they are worn to less than one-half inch in length. If the negative insulated brush holder is shorted to ground, repair the insulation if possible. If not, replace the end plate and reassemble the generator. Install the generator and adjust the belt tension.

C. High Charging Rate

If the generator or lights burn out prematurely, the battery requires too frequent refilling, or ignition contacts are burned, the most common cause is high voltage. Check the voltage regulation. If the voltage regulation is high, replace the regulator.

STARTING SYSTEM

In many cases of starting system trouble, the owner has discharged his battery before calling for assistance. A field service procedure is presented to aid the service man in such cases. The field service is not a part of the diagnosis procedure. Diagnosis appears under the various symptoms of starting system troubles.

When answering a service call, take a fully charged battery and two heavy cables four feet long (equipped with suitable connectors) or a portable Fast Charger, if electric current is known to be available.

If the stalled tractor is near an electric outlet (110 volt AC), use the fast charger to give a "boost" charge to the battery. About 15 minutes of charging is sufficient to permit starting the engine. If a 110 volt AC outlet is not available, use the booster battery for starting. Turn the ignition switch on and pull the choke control out (gasoline or LP-Gas engines only). As soon as this connection is made, the starter should crank the engine. If the starting motor spins but will not crank the engine, the starter drive requires repair or replacement.

If the engine cranks but will not start, the trouble is in the engine (fuel, ignition, engine parts) and not in the starting system. If the engine will not crank with the battery connected as above, the starting motor relay or circuit may be faulty or engine parts may be seized. In either case, move the tractor to the shop for a complete diagnosis.

Table 2 lists the three symptoms and troubles that can cause the symptoms. The order of the numbers in each symptom column indicates either the most probable cause of the symptom or the cause which is easiest to eliminate by testing.

The trouble shooting table presents more detailed information on the various causes of the symptom than the road maps, Figures 38 and 39. The road map groups several of these details into a single test, however, the results of the test will indicate the particular trouble causing the symptoms.

Be sure to follow these procedures carefully. Once the method and steps are fixed in your mind, you will not have to re-read them on each job. Eventually, the road map type illustration will be all that you need.

A. Engine Will Not Crank When Starter Switch is Operated

Several causes will individually result in the symptom "Engine Will Not Crank When Starter Switch is Operated."

The battery may be discharged. The starter switch and starter relay may be inoperative. The circuit may be open or have high resistance. Water may have leaked into the cylinders causing hydrostatic lock. The starter drive may be locked. The starting motor may be faulty or inoperative. Figure 38 illustrates the road map for the symptom, "Engine Will Not Crank."

1. Test the state of charge of battery. If the battery is discharged, follow a. If the battery is charged, follow b.
   a. Recharge the battery and make a high rate discharge test. Replace the battery if the test indicates it is worn out or under capacity.
   b. If the battery is charged, press the starter button to crank the engine. If the engine will not crank and the relay does not click, see Test No. 1, below. If the relay clicks, see Test No. 2, below. If the starting motor spins but will not crank the engine, see paragraph B. "Starting Motor Spins But Does Not Crank Engine."

CAUSES	SYMPTOMS		
	(1) Engine Will Not Crank (See Page 79)	(2) Starting Motor Spins But Will Not Crank Engine (See Page 81)	(3) Engine Cranks Slowly (See Page 81)
Battery Low in Charge	1		2
Battery Defective	2		3
Excessive Circuit Resistance	5		4
Worn Starter Brushes	6		6
Dirty Starter Commutator	7		7
Open or Short Circuited Starter Windings	8		8
Excessive Engine Friction	11		9
Dirty Starter Drive		1	
Starter Drive Broken or Worn		2	
Improper Viscosity Engine Oil			1
Locked Starter Drive	10		
Starting Relay Control Switch Faulty	3		
Starter Relay Inoperative	4		
High Resistance in Relay Contacts			5
Hydrostatic Lock	9		

Table 2—Starting System—Causes of Trouble

Test No. 1. Connect a jumper wire from the negative battery terminal to the battery terminal of the starter relay. If the engine does not crank, the starter relay or the cable connecting the starter relay to the battery is at fault.

Ground the starter button wire to the side panel with a screwdriver or a jumper wire. If the starter relay now clicks, replace the starter button. If a click is not heard, ground the starting motor relay terminal to which the small wire is attached. If the engine now cranks, the wire from the starter relay to the starter button is at fault and must be replaced.

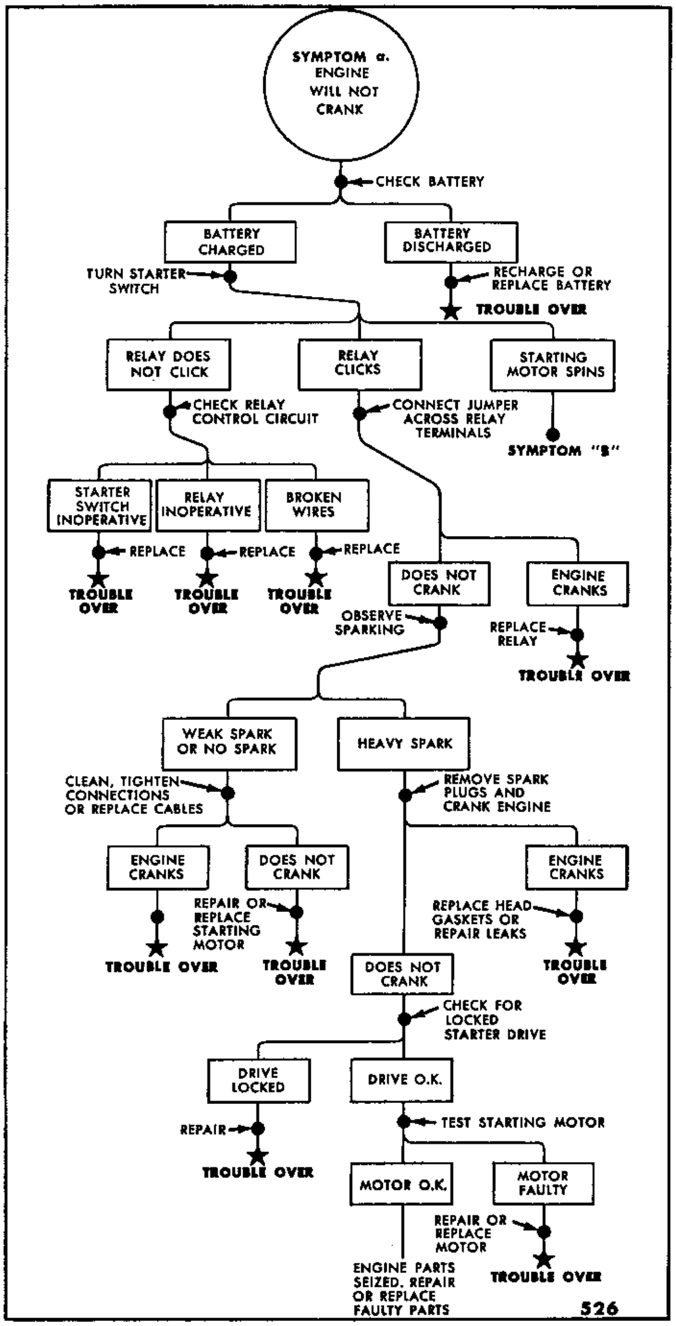


Figure 38—Engine Will Not Crank—Road Map

Test No. 2. If the relay clicks when the starter button is pressed, connect a heavy jumper from the relay battery terminal to the starting motor. If the engine does not crank, observe the spark when connecting and disconnecting the jumper. If there is a heavy spark, see (2) below. If the spark is weak or if there is no spark at all, proceed as follows:

(1) With the jumper wire connected, inspect the battery-starter cables for corrosion and broken connectors. Check the ground cable to see if it is broken or badly corroded. Inspect all cable connections. Clean and tighten them if necessary. Replace any broken or frayed cables. If the engine still will not crank, the trouble is in the starting motor and it must be repaired or replaced.

(2) If a heavy spark is obtained when the jumper wire is connected, remove all the spark plugs and attempt to crank the engine with the starting motor.

If the engine cranks with the spark plugs removed, water has leaked into the cylinders causing a hydrostatic lock. The cylinder head must be removed and the cause of leakage repaired.

(3) If the engine will not crank, loosen the starter mounting bolts to free the starter pinion. If the starter drive is locked, remove the starting motor from the engine and examine the starting motor drive pinion for burred or worn teeth. Exam-

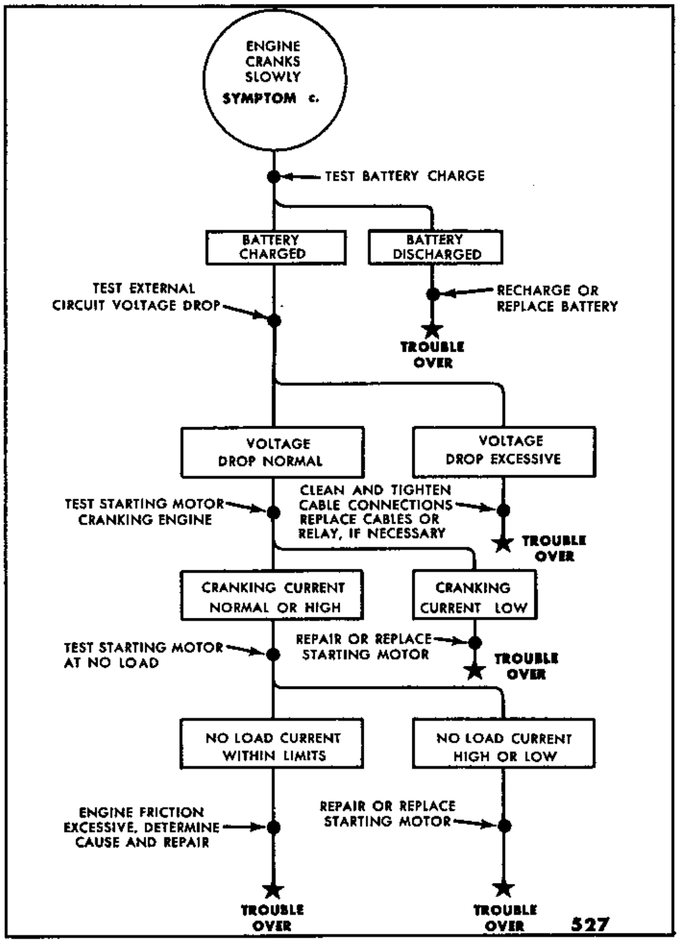

ENGINE CRANKS SLOWLY SYMPTOM c.
TEST BATTERY CHARGE
BATTERY CHARGED
BATTERY DISCHARGED
TEST EXTERNAL CIRCUIT VOLTAGE DROP
RECHARGE OR REPLACE BATTERY
TROUBLE OVER
VOLTAGE DROP NORMAL
VOLTAGE DROP EXCESSIVE
TEST STARTING MOTOR CRANKING ENGINE
CLEAN AND TIGHTEN CABLE CONNECTIONS REPLACE CABLES OR RELAY, IF NECESSARY
TROUBLE OVER
CRANKING CURRENT NORMAL OR HIGH
CRANKING CURRENT LOW
TEST STARTING MOTOR AT NO LOAD
REPAIR OR REPLACE STARTING MOTOR
TROUBLE OVER
NO LOAD CURRENT WITHIN LIMITS
NO LOAD CURRENT HIGH OR LOW
ENGINE FRICTION EXCESSIVE, DETERMINE CAUSE AND REPAIR
REPAIR OR REPLACE STARTING MOTOR
TROUBLE OVER
TROUBLE OVER
527

Fig. 39—Engine Cranks Slowly—Road Map

ine the teeth on the flywheel-ring gear for burrs and wear. Replace the pinion or the flywheel-ring gear if they are worn or damaged.

(4) If the starter drive is not locked, remove the starting motor from the engine and perform the no-load current test. The motor should run freely. Compare the reading obtained from the ammeter with the no-load current test specifications. The motor should run freely. Compare the reading obtained from the ammeter with the no-load draw specification for the starting motor. If the current reading is below specifications, the starting motor is high resistant and should be repaired. If the current reading is above normal, the starting motor is running slower than it should due to tight bearings, a bent shaft, or because the armature is rubbing the field poles. A shorted coil in the starting motor also causes the current reading to be high. Disassemble the starting motor and determine the cause. Repair if possible, or replace the starting motor.

(5) If the current reading of the starting motor is 800 amps. the engine is seized and cannot be turned by the starter. Disassemble the engine and repair or replace the defective parts.

B. Starting Motor Spins But Does Not Crank Engine

If the starting motor spins but will not crank the engine, the starting motor drive is dirty, worn or broken.

1. Remove the starting motor from the engine and inspect the starting motor drive for broken or worn parts. Replace the drive if any parts are worn or broken. Clean the starting motor drive in solvent if dirty or greasy.
2. Install the starting motor drive, if removed, and mount the starting motor on the engine.

   IMPORTANT: ***Do not lubricate the starting motor drive. It should work freely after cleaning in solvent.***

C. Engine Cranks Slowly

When the engine cranks slowly, it may be due to any one of the following. The battery may be low in charge. There may be excessive resistance in the starting motor circuit. The starting motor may be faulty. The engine may have excessive friction.

Figure 39 shows the road map for the symptom, Engine Cranks Slowly.

1. Test the state of charge of the battery. If the battery is low, recharge the battery and make a high rate discharge test. Replace the battery if the test indicates it to be worn out or under capacity. If the battery is charged, test the external circuit voltage drop. If the voltage drop is more than .125, follow a. "Resistance Excessive." If the voltage drop is normal, follow b. "Resistance Normal."

   a. If the resistance (voltage drop) is high, locate the exact part of the circuit with excessive resistance and follow the appropriate steps (1), (2), (3), or (4) given below.

      (1) If the resistance is in the battery-to-starter-relay-cable, clean and tighten the cable connections. If voltage drop is still excessive, replace the cable.

      (2) If the resistance of the starting motor relay contacts is excessive, replace the relay.

      (3) If the resistance is in the starting motor relay-to-starter-motor cable, clean and tighten the cable connections. If the voltage drop is still excessive, replace the cable.

      (4) If the resistance is in the battery-to-ground cable, clean and tighten the cable connections. If voltage drop is still excessive, replace the cable.

   b. If the resistance is normal, test the starting motor current draw while the motor is cranking the engine. If the current draw is normal or excessive, see (2) below. If the current is low (normal 140-190 amperes six-volts or 180-230 amperes twelve-volts), proceed as follows:

      (1) Remove the starting motor from the engine and disassemble the motor. Determine the cause of the trouble and repair it if possible. If not, replace the faulty part, reassemble the starter, and mount it on the engine.

      (2) Test the starting motor current draw at no load. If the current draw is above or below specifications, remove the starting motor from the engine and make the necessary repairs or replace the motor.

      If the current draw at no-load is normal, the starter is OK. The engine has excessive friction and the cause must be determined. Replace the faulty parts.

7. SPECIFICATIONS

Battery

Part No.	Volts	Plates	Ampere Hours
230147	6	13	80
310943	12	15	135

Starting Motor

Part No.	Amperes No Load	Ampere Load Cranking Warm Engine	Cranking Speed	Brush Spring Tension
FAC-11001-E	100	100-150	100 rpm	48-56
2900804	100	190-225	180 rpm	50-58

Generator

Armature Part No.	Engine RPM To Test Voltage	Watt	Brush Wear Length	Maximum Rate (Amps)	Field Resistance Ohms at 70°	Brush Spring Tension
OA-10005-A	1200	160	½″	20 at 1650 rpm	3.2	26-34
OA-1005-A	1500	300	½″	20	7.2	32-40

Generator Regulator

Part Number	Cutout Voltage		Voltage Limiter at Ambient Temp 75°	Reverse Current at Min. of 6 Volts
	Opening at Ambient Temp 75°	Closing at Ambient Temp 75°		
FAC-10505-A	5.5-5.1 Volts	6-6.6 Volts	7.1-7.5	6 Amps Max.
2900446	13.0-11.0 Volts	12.2-13.0 Volts	15.0 + .4 @ 5 amp. load	9.5-6.0 Amps

8. SPECIAL TOOLS

Tool No.	Description
818	Bushing Driver Set
12151	Tension Scale (0-32 oz.
VAT—60	Voltmeter and Ammeter
AT	"Growler" Tester
AA	Jumper Wires

Part ONE

POWER PLANT

Chapter

III

Ignition System

Section **Page**

1. Ignition Switch 83
2. Spark Plugs and Ignition Wires 84
3. Coil 84
4. Distributor 85
5. Trouble Shooting 92
6. Specifications 95
7. Special Tools 96

The ignition system (gasoline and LP-Gas tractors only) consists of a primary (low voltage) and a secondary (high voltage) circuit, Figure 1. The battery, ignition switch, primary wiring of the ignition coil, breaker points and the condenser are in the primary circuit. The secondary circuit is composed of the secondary wiring of the ignition coil, rotor, distributor cap, spark plug wires (high tension) and the spark plugs.

1. IGNITION SWITCH

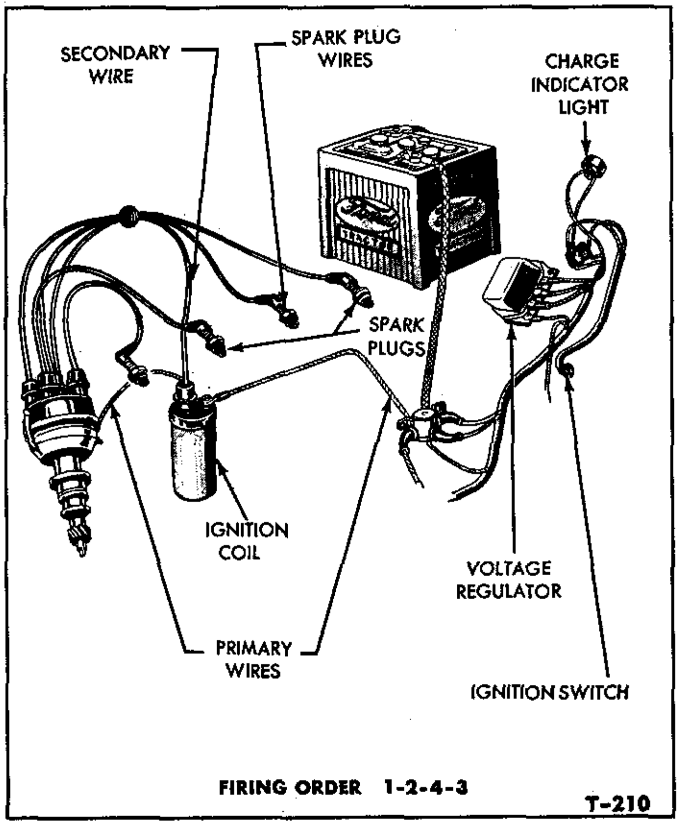


Figure 1—Ignition System

The ignition switch is of the "OFF" and "ON" type and is located on the left side of the lower instrument panel.

A. Removal

1. Disconnect the battery ground cable from the tractor.
2. Raise the hood panel and disconnect the two wires from the switch.
3. Remove the switch attaching nut and lockwasher, then remove the switch from the panel.

B. Installation

1. Position the switch in the lower instrument panel and secure it with a lockwasher and nut.
2. Connect the coil and battery wires to their respective terminals on the switch.
3. Connect the battery cable to the tractor.

2. SPARK PLUGS AND IGNITION WIRES

A. Spark Plugs

1. Spark plugs may become fouled with carbon by leaky or stuck valves, over-rich carburetion, gaps that are set too close, or oil in the combustion chamber due to worn piston rings or valve guides.
2. Spark plugs should be cleaned and tested with equipment made especially for this purpose. Some spark plugs may appear to be serviceable yet leak under compression pressure. This causes the plug to overheat and also results in loss of engine power. Discard plugs with a badly pitted or cracked insulator.
3. Several different spark plug conditions are shown in Figure 2. Under normal operating conditions, the spark plugs should be removed, cleaned, and inspected every 150 hours and replaced every 300 hours of operation.
4. Always use a round wire gauge to check the air gap, see Figure 3, as a feeler gauge will not measure the depression generally burned in the electrodes. Correct air gap is 0.025 to 0.028" for gasoline engines or 0.028 to 0.031" for LP-Gas engines. H-10 heat range plugs (gasoline engine) or H-8 (LP-Gas engines), or equivalent, are engineered to give the best operating results and should always be used when installing new plugs. Size of the spark plug is 14 mm.

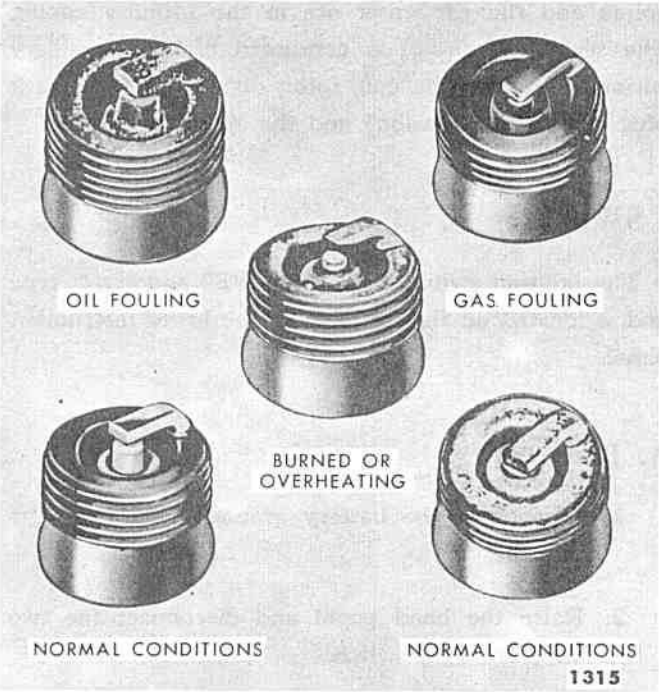


Figure 2—Visual Inspection of Spark Plugs

B. Ignition Wires

The secondary (high tension) wires, Figure 1, should be inspected periodically to see that they are not oil soaked, do not have cracked insulation or loose terminals.

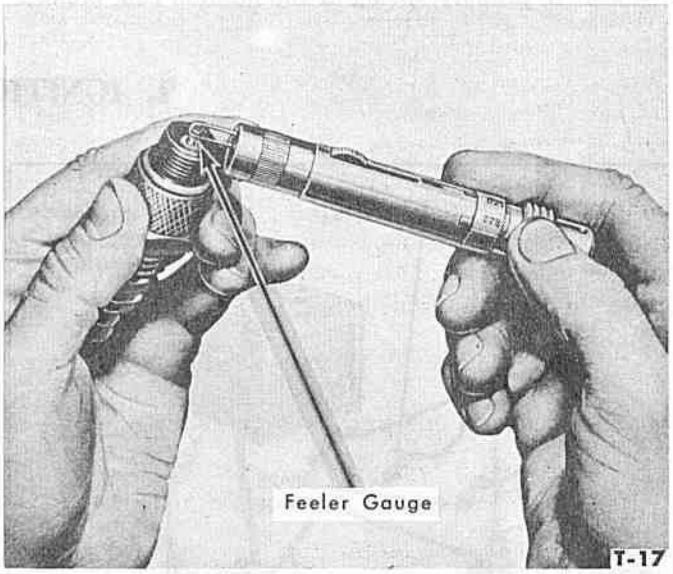


Figure 3—Checking Spark Plug Gap

3. COIL

The same type of ignition coil is used on all Ford Tractors with gasoline or LP-Gas engines. The coil is mounted on the right side of the cylinder block to the rear of the distributor.

A. Removal

1. Disconnect the primary and secondary leads from the coil, Figure 1.
2. Remove the two cap screws and lockwashers that attach the coil and bracket assembly to the cylinder block and remove the coil.
3. Loosen the bracket attaching screw and separate the coil from the bracket.

B. Inspection

1. Visually inspect the coil for being broken,

cracked or having broken or damaged terminals. Replace the coil if any of these conditions are evident.

2. Perform a coil secondary, continuity and capacity test following the instructions of the test set manufacturer. Replace the coil if not up to specifications.

C. Installation

1. Secure the coil in the mounting bracket.
2. Hold the coil in place on the cylinder block with the terminals facing upward and secure with the two cap screws and lockwashers.
3. Connect the distributor primary wire to the "DIST" terminal and the other primary wire to the "BAT" terminal with nuts and lockwashers.

   NOTE: ***Be careful not to overtighten the primary terminal nuts and break the studs.***

4. Push the secondary wire (high tension) into the coil socket as far as possible then slip the rubber seal into place.

4. DISTRIBUTOR

The distributor is mounted on the right side of the engine and is driven by a gear on the camshaft. One of the distributor functions is to interrupt the current flow through the primary winding of the ignition coil, thus causing the coil to produce voltage high enough to jump the gap at the spark plugs at the desired instant during the compression stroke. As engine speed increases, the spark must occur earlier at the spark plugs. This is accomplished by an automatic spark advance that is controlled by centrifugal weights in the distributor. This is necessary to allow the fuel air mixture sufficient time to ignite and burn. The centrifugal weights, advance the breaker cam to give a predetermined variation in spark advance for different engine speeds. An accurate measurement of spark timing at any given engine rpm can only be determined on the engine by use of a timing light.

A. Removal

1. Disconnect the primary wire at the distributor.
2. Unsnap the two distributor cap bale clamps and lift the distributor cap off the distributor.
3. Scribe a mark on the dust cap opposite the rotor contact. Note the position of the primary terminal on the distributor so that it may be located in the same approximate position when installing the distributor.
4. Remove the two screws and distributor clamps then lift the distributor out of the cylinder block.

   NOTE: ***Do not crank the engine after the distributor has been removed.***

B. Disassembly

1. Place the distributor in Holding Block 12132-C. Remove the rotor and distributor shaft spring, Figure 4, from the distributor shaft.
2. Lift the breaker dust cover, retainer, seal and gasket from the distributor as an assembly.
3. Remove the nut and lockwasher that connects the condenser lead and primary conductor to the breaker points.
4. Remove the screws that attach the breaker points and condenser to the breaker plate.
5. Remove the two screws that attach the breaker plate to the distributor base. Lift the plate from the base.
6. Remove the nut, lockwasher, insulator bushing, insulator, conductor, and brass screw from the distributor base.
7. Remove the snap ring that secures the cam and weights to the distributor shaft. Lift the cam and weights from the shaft.
8. File the upset end of the rivet that secures the distributor gear to the shaft until it is flush with the gear. Remove the rivet with a punch.
9. Remove the gear from the shaft with Remover 12390-C-3, as shown in Figure 5.
10. Carefully pry the oil seal out of the lower end of the distributor base.
11. With the distributor base in the inverted position, drive the bushing out of the base with Distributor Shaft Bushing Remover 12132-B-1, as shown in Figure 6.

    NOTE: ***Do not remove the bushing if not necessary to replace it. See paragraph C. 2.***

C. Cleaning and Inspection

1. Soak all parts of the distributor assembly (except the condenser, breaker point assembly, and

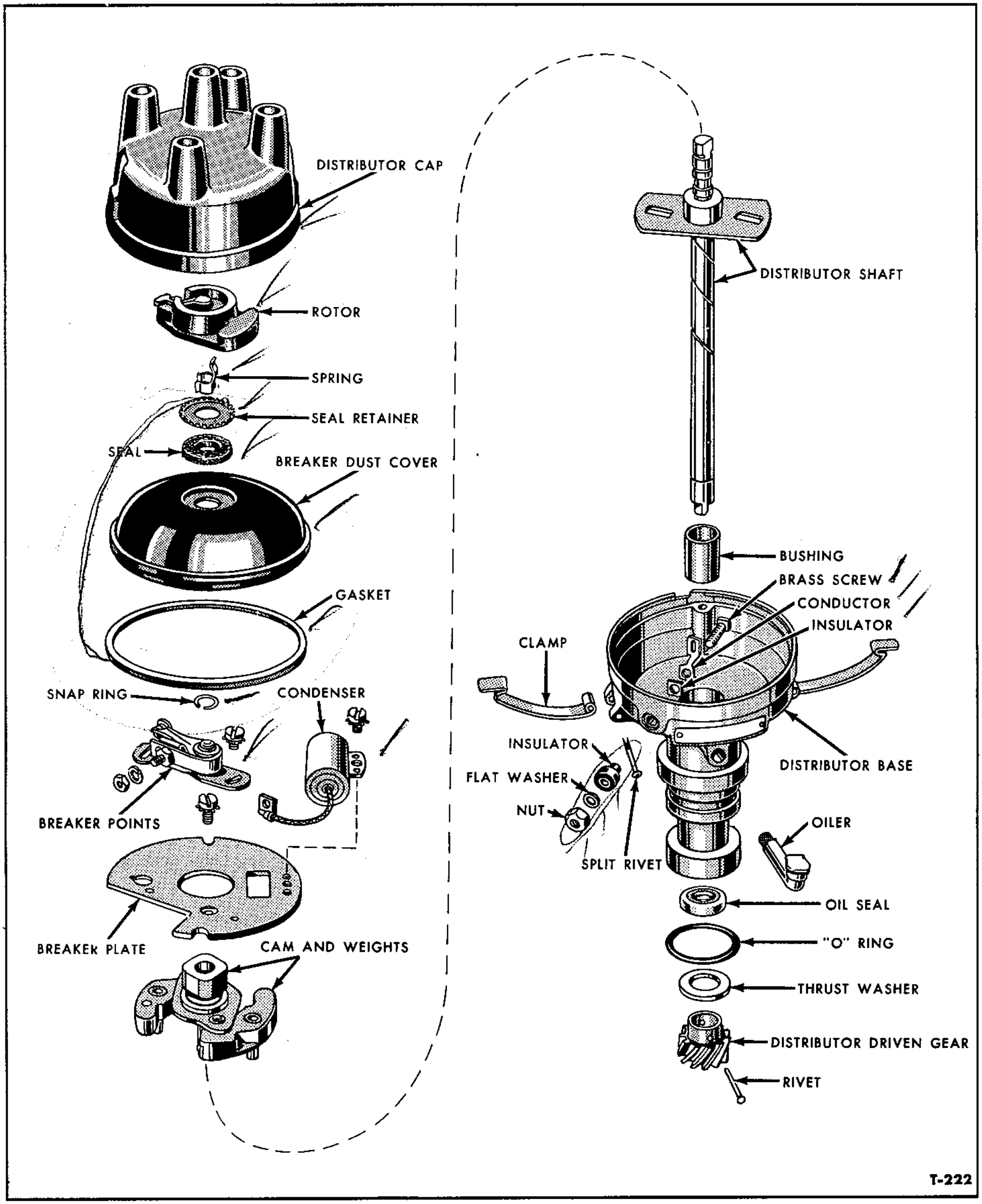


Figure 4—Distributor—Disassembled

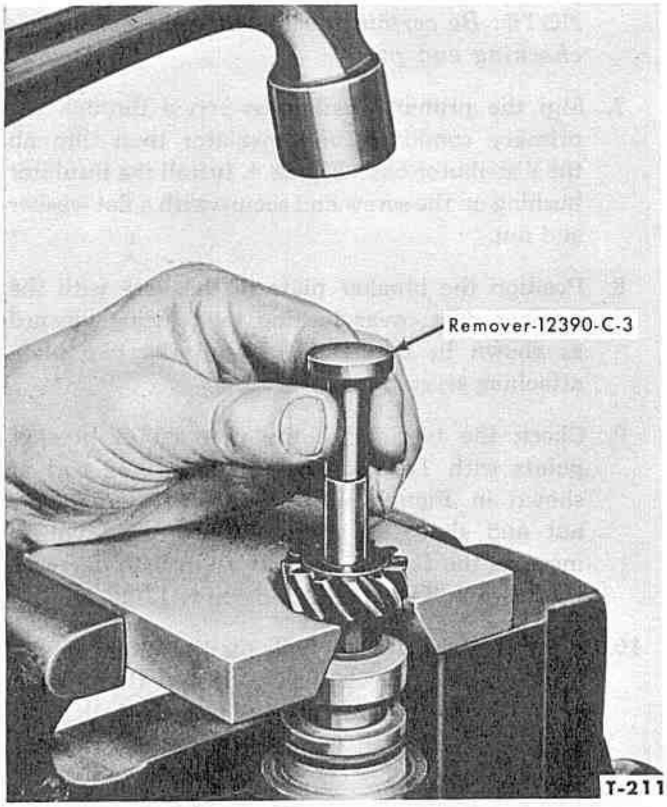


Figure 5—Removing Distributor Gear

insulator) in a mild cleaning solvent or mineral spirits. DO NOT USE A HARSH CLEANING SOLUTION. Wipe all parts that can not be immersed in a solvent with a dry, clean cloth. After foreign deposits have been loosened by soaking, scrub the parts with a soft bristle brush. DO NOT USE A WIRE BRUSH, FILE OR OTHER ABRASIVE OBJECT. Dry the parts with compressed air.

2. Examine the bushing surfaces of the distributor shaft and examine the bushing for wear. The minimum allowable shaft diameter at the bushing surface is 0.4665″. The maximum allowable inside diameter of the bushing is 0.471″. Replace worn parts.

3. Inspect the cam lobes for scoring and signs of wear. If any lobe is scored or worn, replace the cam and weights.

4. Inspect the breaker plate assembly for signs of distortion or other defects. Replace the plate if it is defective.

5. The breaker point assembly and condenser should be replaced whenever the distributor is overhauled.

6. Replace the primary conductor and the insulator if broken or damaged.

7. Check the distributor base for cracks or other damage. Replace all defective parts.

D. Assembly

1. Place the distributor base in Holding Block 12132-C. Drive a new distributor shaft bushing into the housing with Distributor Shaft Bushing Replacer 12132-E, as shown in Figure 7, if it was removed.

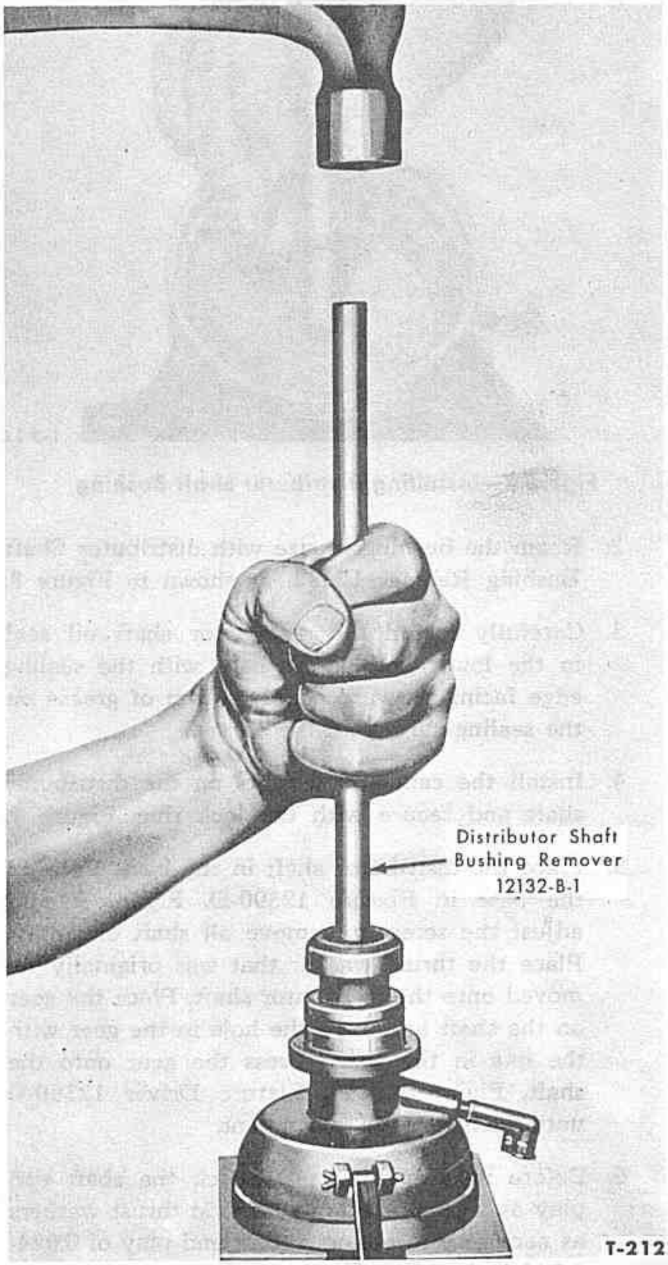


Figure 6—Removing Distributor Shaft Bushing

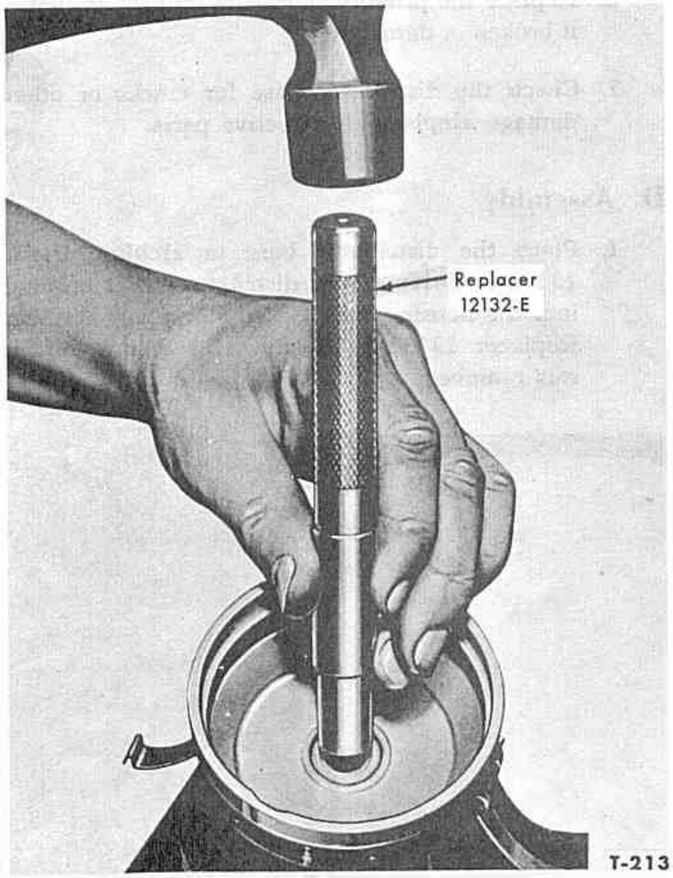


Figure 7—Installing Distributor Shaft Bushing

2. Ream the bushing to size with distributor Shaft Bushing Reamer 12132, as shown in Figure 8.

3. Carefully install the distributor shaft oil seal in the lower end of the base with the sealing edge facing outward. Apply a film of grease on the sealing surface of the oil seal.

4. Install the cam and weights on the distributor shaft and secure with the lock ring, Figure 4.

5. Place the distributor shaft in the base. Position the base in Fixture 12390-D, Figure 9, and adjust the screw to remove all shaft end play. Place the thrust washer that was originally removed onto the distributor shaft. Place the gear on the shaft and align the hole in the gear with the one in the shaft. Press the gear onto the shaft, Figure 9, with Fixture Driver 12390-C until the holes are in alignment.

6. Before installing the pin, check the shaft end play as shown in Figure 10. Add thrust washers as necessary to obtain a shaft end play of 0.024-0.046 inch. After the correct end play has been obtained, install and peen the rivet.

NOTE: ***Be certain not to move the gear when checking end play.***

7. Slip the primary lead brass screw through the primary conductor and insulator then through the distributor base, Figure 4. Install the insulator bushing on the screw and secure with a flat washer and nut.

8. Position the breaker plate in the base with the breaker dust cover locking tang facing upward as shown in Figure 11. Install the two plate attaching screws.

9. Check the tension on the new set of breaker points with Tension Scale 12151 (0-32 oz.) as shown in Figure 12. If necessary, loosen the nut and slide the spring toward the pivot to increase the tension or away from it to decrease the tension. The correct tension is 17-20 oz.

10. Apply a light film of high melting point grease to the distributor shaft cam. Install the breaker points on the breaker plate making sure that the pivot pin is seated in the hole provided in the breaker plate.

11. Bend the stationary point as required, with Adjusting Tool 12150-E, Figures 13 and 14, to align the points and make both contacts parallel and in alignment with each other.

12. Rotate the cam until the rubbing block of the breaker arm is at the high point of the cam.

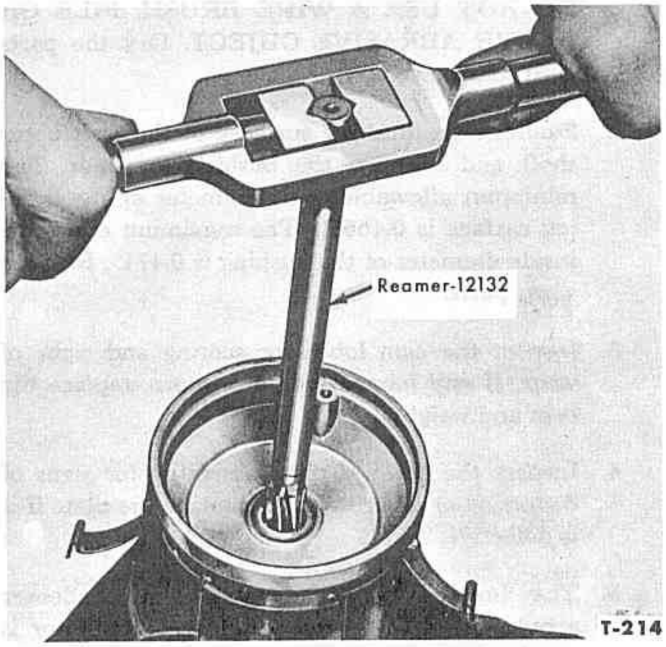


Figure 8—Reaming Distributor Shaft Bushing

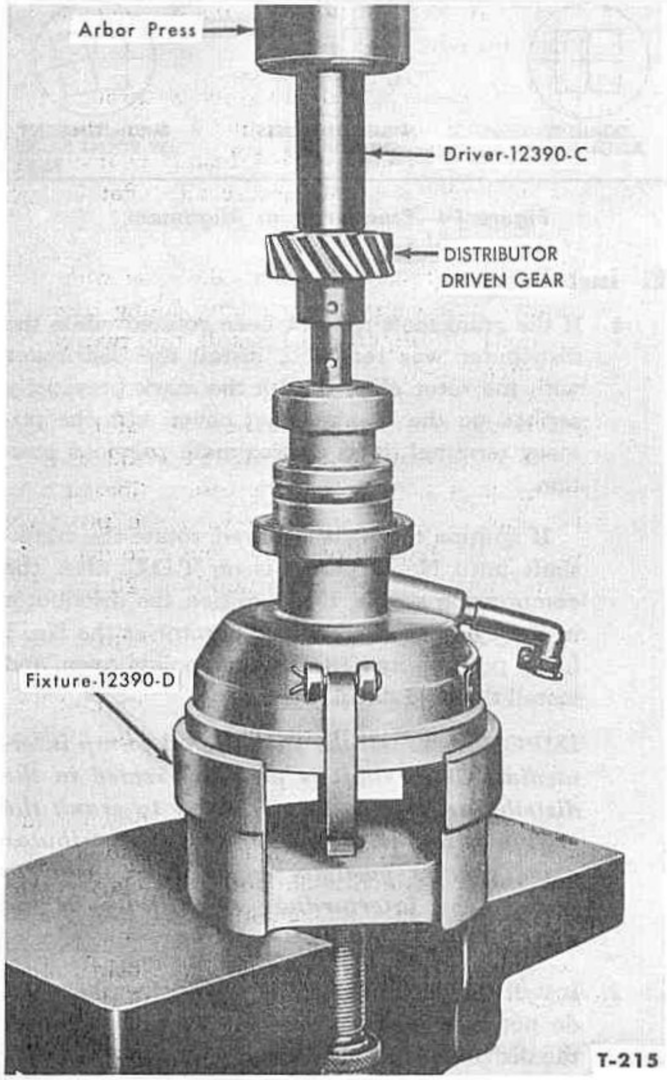


Figure 9—Installing Distributor Gear

Make sure the screws are loose enough to allow adjustment.

Insert the adjusting blade of the Adjusting Tool 12150-E, in the adjustment opening and turn in the proper direction to obtain an air gap of 0.024" to 0.026". Use a round wire gauge to check the air gap.

IMPORTANT: ***Be sure to wipe the gauge with a clean cloth before inserting it between the points.***

Tighten the screws and recheck the air gap, after rotating the cam so the rubbing block is on another lobe.

13. Install the condenser on the breaker plate. Connect the condenser lead and primary conductor to the breaker points and secure with a nut and lockwasher.

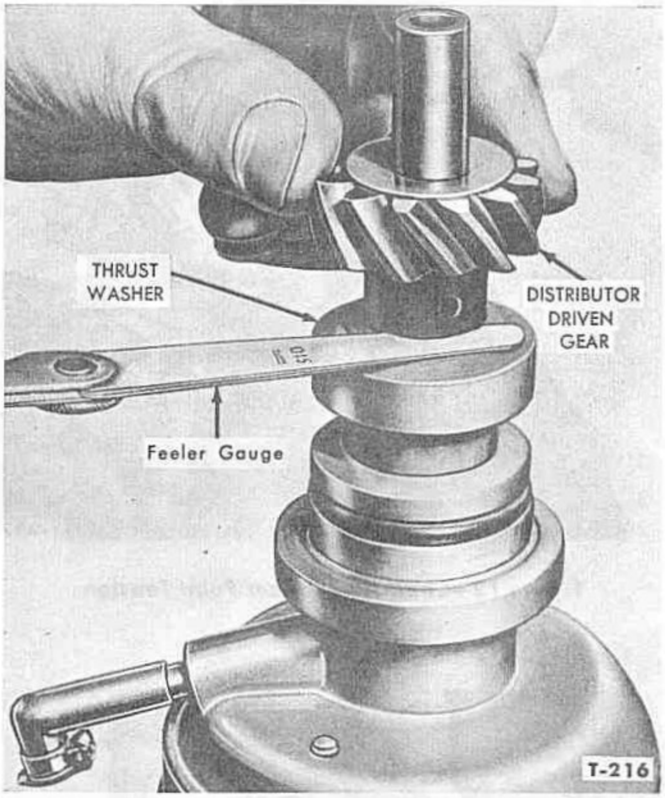


Figure 10—Checking Distributor Shaft End Play

14. Install a new gasket, seal and seal retainer on the breaker dust cover and install the cover on the distributor.
15. Install the distributor shaft spring and rotor on the shaft.

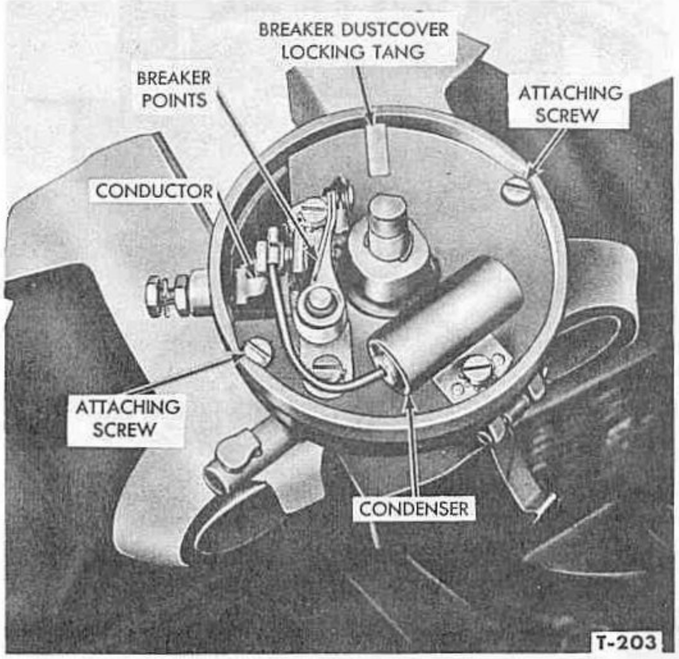


Figure 11—Top View of Distributor

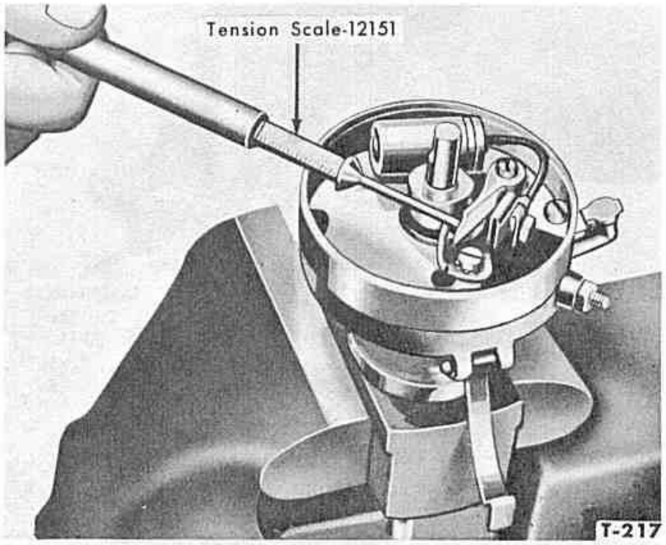


Figure 12—Checking Breaker Point Tension

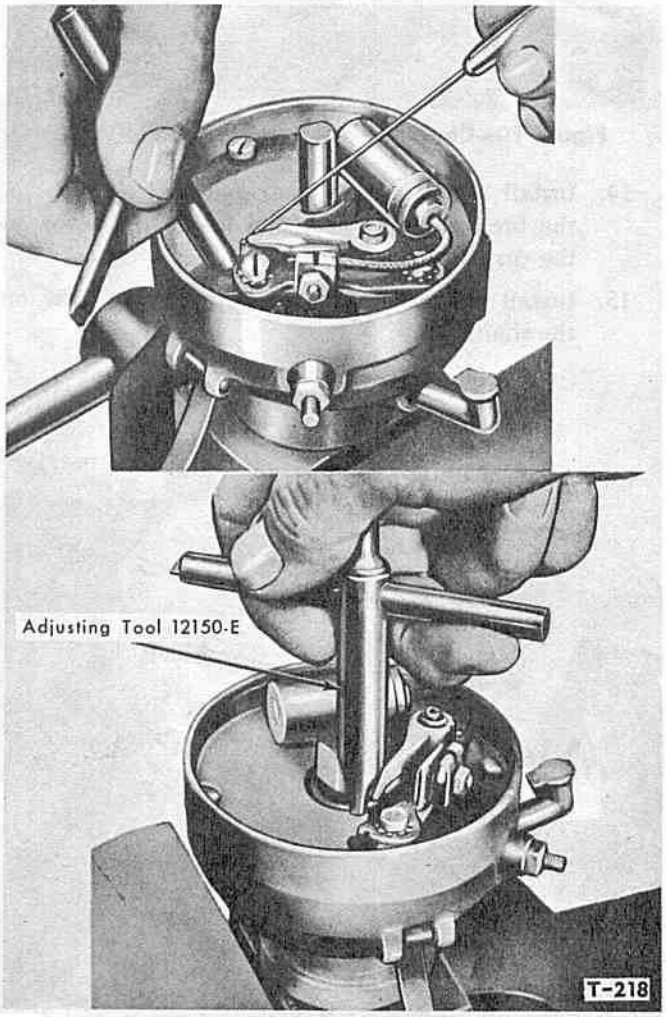


Figure 13—Aligning and Adjusting Breaker Points

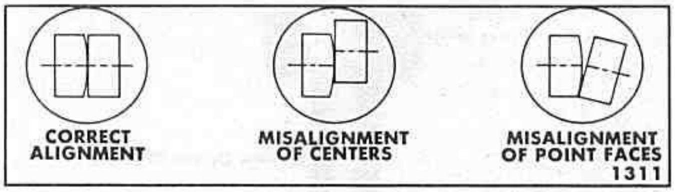


Figure 14—Breaker Point Alignment

E. Installation

1. If the crankshaft has not been rotated while the distributor was removed, install the distributor with the rotor aligned with the mark previously scribed on the breaker dust cover with the primary terminal in its approximate previous position.

   If ignition timing is required, rotate the crankshaft until No. 1 piston is on T.D.C. after the compression stroke, then position the distributor in the cylinder block with the rotor at the No. 1 firing position and the breaker points open, and install the hold down clamps.

   IMPORTANT: ***Make sure the oil pump intermediate drive shaft is properly seated in the distributor. It may be necessary to crank the engine with the starter after the distributor drive gear is partially engaged, in order to engage the intermediate shaft fully in the distributor.***

2. Install the retaining screws and lockwashers but do not tighten the screws at this time. Connect the distributor primary wire.

3. Rotate the distributor base clockwise until the breaker points are just starting to open. Tighten the screws. Install the rotor and distributor cap. Start the engine, and check the ignition timing and centrifugal advance with a timing light.

F. Setting Basic Ignition Timing

1. Place the gear shift lever in neutral position and turn the ignition switch off before attempting to set ignition timing.

2. Remove the distributor cap from the distributor and the spark plug from the number one cylinder.

3. Hold your thumb over the spark plug hole as the engine is cranked. Observe the distributor rotor closely while it rotates, then mark its exact location on the breaker dust cover the moment compression blows by your finger.

4. Press the starter button again until the rotor is almost in alignment with the rotor location mark placed on the dust cover and compression is felt at the number one spark plug hole. Stop the rotor in this position.

5. Remove the timing hole cover on the flywheel housing. Observe the location of 4° before top dead center for all models, Figure 15. If the mark does not align with the pointer, insert a screw driver in the timing hole and rotate the flywheel until the correct mark on the flywheel does align with the timing pointer on the housing.

6. When the 4° mark aligns with the pointer, the number one piston is before top dead center position on the compression stroke ready to fire. In this position, the ignition contact points should just begin to separate and the rotor must point to the number one spark plug wire. This is the basic ignition timing setting for idle speed (450-475) rpm.

7. If ignition points must be moved to obtain their separation point, loosen the clamp screws on the distributor base and turn the distributor manually. To advance ignition timing, turn the distributor base counterclockwise. To retard ignition timing, turn the distributor base clockwise.

   NOTE: ***In the event that the distributor base must be turned more than 10 or 12 degrees, lift the distributor vertically until the distributor rotor can be turned to the number one spark plug wire location. It will be necessary to reposition the oil pump shaft to properly align the hex drive. Install the distributor clamp retainers and tighten securely.***

G. Ignition Timing with Timing Light

1. Remove the No. 1 spark plug wire from the distributor cap. Plug a timing light adapter into the distributor cap and into the wire. Connect the secondary (high tension) lead of the timing light to the adapter.

2. Connect the primary positive lead (RED) of light to a ground. Connect the primary negative lead (BLACK) to the battery terminal of the ignition coil.

3. Remove the timing cover plate. Direct the light onto the flywheel. Timing should be 4° before top dead center at idle speed (450-475 rpm) for all models.

4. Start the engine and run it at idle speed (450-475 rpm).

5. If the timing at 450-475 rpm does not concur with Figure 15, loosen the distributor mounting screws and turn distributor counterclockwise to advance the timing or clockwise to retard the timing. Be sure to tighten the mounting cap screws securely, after adjustment. Recheck the timing after the distributor is tightened securely.

H. Checking Distributor Centrifugal Advance

Correct basic engine timing does not indicate that the engine spark timing is correct throughout the various speed ranges. After the engine speed reaches 500 revolutions per minute, spark advance is controlled by the centrifugal advance mechanism built in the base of the distributor. The use of a timing light, directed on the flywheel degree markings, is necessary to determine whether the centrifugal advance range (above 500 rpm) shown in the following chart is correct.

Series	450-475 RPM Crankshaft Degrees B.T.D.C.	1200 RPM Crankshaft Degrees B.T.D.C.	No Load 2200 RPM Crankshaft Degrees B.T.D.C.	Rated Speed
ALL	4°	13°	24°	With Four Speed Transmission, 2000 RPM With Five or Ten Speed Transmission, 2200 RPM

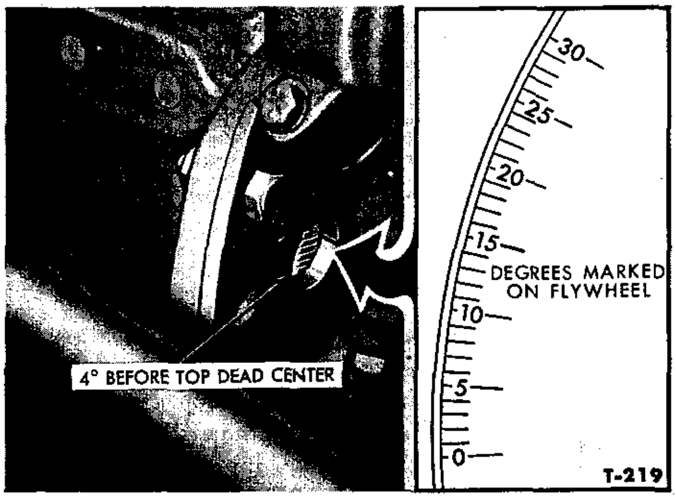


Figure 15—Flywheel Timing Marks

5. TROUBLE SHOOTING

The ignition system is composed of a primary and a secondary circuit. The battery, ignition switch, primary coil winding, distributor points, condenser, and primary wiring are in the primary circuit. The secondary winding of the coil, rotor, distributor cap, high tension wiring and spark plugs compose the secondary circuit.

A. No Spark At Any Spark Plug Wire

This indicates trouble in the primary circuit, in the rotor or in the high tension wire between the coil and the distributor.

1. Turn the ignition switch on. Hold the end of one spark plug wire $\frac{3}{16}$ inch from the cylinder head while the engine is being cranked. Repeat this procedure in turn at each spark plug wire.

   If none of the spark plug wires produce a spark this symptom applies. If a spark jumps the gap from any one or several wires, this symptom does not apply.

   The following procedure is designed to quickly locate the immediate cause of trouble, so that the engine can be started.

   A schematic drawing of the ignition circuit is shown in Figure 16. The numbers appearing in this drawing establish the location of units in the circuits.

   EXAMPLE: ***In the following instructions and in the drawings, (7) refers to the coil terminal of the ignition switch to coil wire.***

2. Check for good connections and firmly seated terminals, then continue as follows:

   a. Replace the coil to distributor high tension wire if the insulation is worn or damaged at any point where it passes near metal parts of the engine. Make sure the terminal (16) is soldered to the wire and is firmly seated into the coil terminal socket. Make sure the coil to distributor primary wire is making good contact at both ends. If trouble still exists, proceed as follows:

   b. Connect an ammeter between the battery negative terminal (14) and the battery terminal of the ignition coil (7). Turn off the ignition switch. Crank the engine with the starter, observe the ammeter reading while the engine is cranking, then follow the proper procedure.

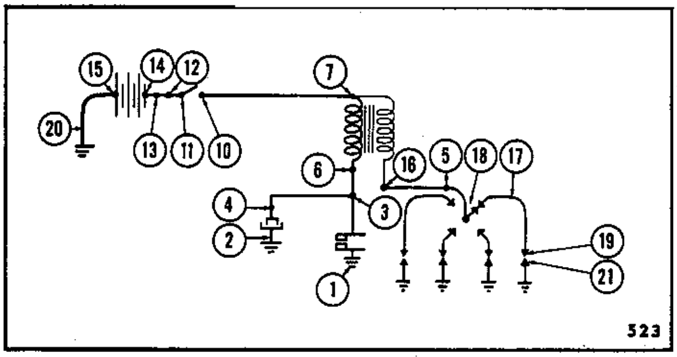


Figure 16—Tractor Ignition System

(1) If the engine starts, the trouble is in the primary circuit from the negative (hot) side of the starter relay (13) to the battery terminal of the ignition coil (7).

NOTE: ***Do not run the engine for more than five minutes with the wires connected in this manner.***

Momentarily disconnect the ammeter lead from the battery (14) to stop the engine. If the ammeter now reads zero, crank the engine, a little at a time (with the starter), until a continuous reading is obtained (distributor points closed). Disconnect the ammeter leads from the battery and coil terminals. Disconnect the battery wire from the coil terminal (7). Turn on the ignition switch. Connect the ammeter positive lead to the coil terminal (7).

Working from the coil toward the battery, contact the ammeter negative lead consecutively to each of the primary circuit terminals (7) to (13) until an ammeter reading from 3 to 5 amperes is obtained. The faulty part of the circuit is between the terminal where a zero reading was obtained and the terminal where a 3 to 5 ampere reading is obtained.

Clean corroded terminals, tighten terminals, and repair or replace parts at fault.

(2) If the ammeter reads zero as the engine is cranked, the trouble is in the primary circuit from the battery terminal (7)

of the coil to the grounded side (1) of the distributor contact points.

Ground the condenser insulated terminal (4). If the ammeter now reads zero, make sure the coil to distributor primary wire is not broken and that it is making good contact at both ends (6) and (3). If the ammeter still reads zero, replace the coil.

If the ammeter reads 3 to 5 amperes when the condenser is grounded, the trouble is in the distributor points or the primary circuit contact (3) to the breaker arm assembly. Replace or adjust the distributor points, or repair the primary circuit contact (3).

(3) If the engine does not start and the ammeter reads from 3 to 5 amperes as the engine is cranked, the trouble is in the condenser or the ignition secondary circuit.

Tighten the ignition condenser terminal screws (2) and (4).

Remove the high tension wire (16) from the coil. Connect a jumper wire into the high tension terminal (16) of the coil. Hold the other end of this jumper wire 3/16 inch from the cylinder head while the engine is cranked with the starter.

If there is no spark, remove the condenser for test, or replace it with one known to be good. If this has not corrected the trouble, replace the coil.

(4) If the spark from the jumper wire is satisfactory, the trouble is a grounded secondary circuit in the distributor rotor or distributor cap. Remove and test the rotor. Replace the rotor if the test indicates high tension circuit leaks due to carbon tracks or due to cracked insulation between the electrode and the distributor shaft. Also make certain that the rotor spring is contacting the brush in the center of the distributor cap. If the rotor is satisfactory, carefully examine the distributor cap for carbon tracks to the distributor housing, due to moisture or foreign matter. Clean the cap with lacquer thinner. Replace the cap if it has carbon tracks.

B. Satisfactory Spark From Some But Not All Spark Plug Wires

The trouble lies within the distributor cap or the remainder of the secondary circuit to the spark plugs.

1. Test the spark from the end of each spark plug wire at idle speed. The spark should jump a 3/16″ gap continuously. A spark that fails to jump this gap regularly, without missing, is considered a weak spark.

   DEFINITION: ***A satisfactory spark is one that will, without missing, regularly jump a spark gap equivalent to the resistance offered by a correctly spaced spark plug under the compression pressure encountered in the operation of the engine.***

   The fact that a satisfactory spark is obtained from some spark plug wires eliminates from consideration those factors that affect equally the output of all the spark plug wires, which are the primary circuit and the secondary circuit through the coil and high tension coil wire, up to the distributor rotor and cap.

   The following procedure takes into account each of the factors that could account for this symptom, in the order of their probability.

   The numbers appearing in drawing, Figure 16, of the ignition circuit, establish location of the terminals referred to in the text.

2. An unsatisfactory spark at some but not all of the spark plug wires indicates faulty installation or serious resistance (air gap) in the high tension circuit.

   a. Replace spark plug wires if the insulation is damaged. Make sure all spark plug wires are soldered to their terminals. Make sure the spark plug wire terminals and the terminal sockets are free from corrosion and the wires are firmly seated in the distributor cap. If the above procedure has not corrected the trouble proceed as follows:

   b. Remove the distributor cap, then clean the cap with lacquer thinner. Replace the distributor cap if it is burned, cracked, or has carbon tracks. Make sure the spark plug wires seat firmly in the sockets.

   c. Check the rotor for proper fit on the shaft and for proper clearance to distributor cap terminals.

C. Intermittent Spark At All Spark Plugs

The trouble is in the primary circuit or coil to distributor lead.

1. Test the spark from the end of each spark plug wire at idle speed. A spark that fails to jump a 14 kilovolt spark setting continuously, is considered an intermittent spark and the following procedure applies.

   When the spark delivered at the end of the spark plug wire is satisfactory but intermittent, the primary ignition circuit is logically given first consideration in the diagnosis procedure. The fact that between "misses" the spark is satisfactory, precludes the possibility that the trouble is in the secondary circuit. The exception would be in relatively rare cases of intermittent breakdown of the insulation in the coil, or when moisture, oil or foreign matter is allowed to accumulate in sufficient quantity on the distributor cap or distributor rotor to conduct the high tension circuit intermittently to ground.

   The numbers in the following text refer to the terminals in Figure 16.

2. Tighten all connections, replace or adjust the contact points, test the coil and test the condenser.

   a. Tighten all connections in the primary circuit, including both terminals of the condenser (2) and (4) and both ends of both battery cables (13), (14), (15) and (20). Tighten the ignition switch terminals (10) and (11).

      Make sure the coil to distributor high tension wire terminal (16) is soldered to the wire and seated all the way into the high tension terminal of the coil. Make sure that the high tension wire socket in the coil is not dirty or corroded. If the trouble still exists, proceed as follows:

   b. Replace or adjust the distributor points if required. Make sure the breaker arm is not binding on its bearing and the spring tension is correct. Reset the timing, and again test the quality of the spark. If the spark is still intermittent, test the coil and condenser.

   c. Test the condenser capacity, leakage, and series resistance. If the coil and condenser are both satisfactory, examine the distributor cap, housing, and rotor for moisture, oil, or foreign matter which might cause an intermittent leak of high tension current to ground. Remove oil and foreign matter with lacquer thinner, and replace the parts having carbon runs imbedded in the surface.

D. Weak Spark At All Spark Plug Wires

The trouble lies in the primary circuits, distributor rotor or coil high tension wire. A weak spark at all plugs is caused by units that have an equal effect on all the wires.

1. With the engine idling, test the quality of the spark from the end of each spark plug wire. The spark should jump a 14 kilovolt gap (about $\frac{3}{16}$ inch). This test assures sufficient spark energy at the spark plug terminals when under 120 pounds compression. If the spark jumps this gap regularly without missing, it is satisfactory. If a satisfactory spark is obtained from some but not all spark plug wires, refer to the symptom "Satisfactory Spark From Some But Not All Spark Plug Wires."

   The following procedure applies only where a weak spark is obtained from all of the spark plug wires.

   The entire primary circuit, including the distributor points, has an equal effect at all spark plug wires. The condenser, coil, distributor rotor and rotor gap have an equal effect at all spark plug wires. The high tension wire from the coil to the distributor also influences the output of all plug wires. These units control spark intensity.

   It is possible for all spark plug wires or all terminals to leak, however, this is considered unlikely. For this reason, the following procedure considers the more probable causes first, in the order of their accessibility.

2. Since the ignition secondary output is dependent on the primary voltage, the condition or state of charge of the battery is an important consideration. If the battery will not crank the engine, recharge or replace the battery.

   a. The ignition primary circuit is tested in two steps as follows:

      (1) Measure the distributor point dwell.

      (2) If the dwell is within 27°-31°, proceed with (b) "Test Battery To Coil Resistance."

      NOTE: ***When the points are new, be sure to also check the gap setting with a feeler gauge (0.024-0.026).***

      If the dwell is not within these limits, replace points that are visibly burned or pitted, then adjust the points to obtain the correct gap setting and spring tension.

b. Since the output of the ignition secondary circuit is limited by the strength of the primary circuit, extra resistance in the primary circuit reduces output.

(1) Disconnect the battery wire from the coil (7) and install an ammeter in series at this point. Connect a voltmeter from the battery negative terminal to ground. Turn the ignition switch "ON." If the ammeter reading is zero, crank the engine to close the breaker points. Divide the voltage reading by the amperage reading to determine total resistance of the primary circuit.

EXAMPLE: ***6.3 volts divided by 5.2 amperes, equals 1 ohm.***

Total resistance of the ignition primary circuit is normally 1.2 ohms cold or 1.6 ohms when hot.

(2) If the resistance of the primary circuit is higher than normal, leave the ammeter connected in series and connect the voltmeter in parallel in turn to each of the units in the circuit. Replace units having high resistance.

Normal resistance of the individual units is:

UNIT	HOT	COLD
Ignition switch	0.02 ohms	0.02 ohms
Ignition coil (primary)	1.40 ohms	1.15 ohms

If the trouble still exists, proceed as follows:

c. Test the coil, condenser, and breaker points in the following sequence:

(1) Remove the high tension wire from the coil and install a jumper wire 12 inches long, in its place. Turn the ignition switch "ON." Hold the end of the jumper wire 3/16 inch from the cylinder head while the engine is being cranked.

If the spark jumps this gap regularly, both the coil and condenser are satisfactory. Proceed with (2).

If the spark fails to jump a 3/16" gap, replace the condenser with one known to be good. If the spark is now satisfactory, the trouble has been corrected. If the spark still fails to jump this gap, remove the coil and test the output on a distributor stroboscope. If this test reveals the coil to be unsatisfactory, proceed with (3).

(2) Clean the distributor cap and rotor with lacquer thinner. Replace these parts if any carbon tracks are visible or if the electrodes have eroded to the extent that the rotor gap has been increased.

Replace the rotor if there is any indication that it shorts through to the distributor shaft under load.

Make sure all high tension wire terminals are soldered to the wires and that their terminal sockets are free from corrosion.

(3) Replace the distributor points if they are burned or misaligned. Establish the correct dwell on the distributor stroboscope. Reset the distributor timing.

6. SPECIFICATIONS

Distributor

Part No.	Models	Basic Timing 450-475 rpm	Advance at 1200 rpm	Advance	Point Spacing	Breaker Arm Spring Tension	Dwell 450-475 rpm	End Play	Rotation
FDN 12127A	501, 601, 701	4 Degrees B.T.D.C.	12-14 Degrees	2200 rpm 24 Degrees	0.024-0.026	17-20 oz.	27°-31°	0.024"-0.046"	Clockwise
FDN 12127A	801, 901, 1801	5 Degrees	14½-16½ Degrees	2200-2400 rpm 26-28 Degrees	0.024-0.026	17-20 oz.	58-63	0.026"-0.037"	Clockwise

Spark Plugs

Part No.	Type	Size	Gap (Inches)	Torque
9N-12405	H-10	14 mm.	0.025″-0.02″	24-30 Ft. Lbs.
NCA-12405A	H-8	14 mm.	0.028″-0.031″	24-30 Ft. Lbs.

Coil

Part Number	Primary Ohms Resistance	Secondary Ohms Resistance
8BA-12029	1.06-1.17 at 75° F.	3800-4300 at 75° F.

Manifold Vacuum in H.G. at Sea Level

RPM	No Load
450	18 in.

Condenser

Part Number	Capacity	Minimum Insulation Resistance	Power Factor	Oil Tight At
7RA-12300-C	21-25 MFD	5 megohms at 210°F.	0.6% at 60 Cycles 70°-75°F.	240°F.

7. SPECIAL TOOLS

The following tools should be used when overhauling a distributor and are illustrated in the preceding sections of this manual.

Tool No.	Description
12132	Reamer—Distributor Shaft Bushing
12390-D	Fixture—Installing and Locating Distributor Gear.
12132-C	Holding Block—Distributor.
12132-B-1	Remover—Distributor Shaft Bushing.
12390-C	Remover Kit—Distributor Shaft.
12132-E	Replacer—Distributor Shaft Bushing.
12151	Scale—Breaker Point Tension.
2150-E	Tool—Breaker Point
PTL-45-1	Timing Light.
▲ ▲	Coil and Condenser Tester.

Part ONE

POWER PLANT

Chapter

IV

Fuel and Exhaust System—Gasoline

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2. Carburetor 99
3. Fuel Tank, Sediment Bowl and Lines 103
4. Manifold, Muffler and Exhaust Pipe 104
5. Trouble Shooting 107
6. Specifications 108
7. Special Tools 108

The fuel system on all Ford Tractors with gasoline engines is of the gravity feed type. The fuel tank is located above the engine, under the hood. Therefore, the fuel can flow down to the carburetor by gravity alone, eliminating the necessity for a fuel pump. The components of the fuel system are the air cleaner, the fuel tank, shut-off valve and lines, the carburetor, fuel strainer and the intake manifold. Service information on each component of the fuel system is provided under the section headings outlined above.

1. AIR CLEANER

Ford Tractors are equipped with an oil bath type air cleaner, Figure 1. The air cleaner is mounted on the left side of the tractor at the rear of the engine. The air intake for the air cleaner is located in the hood left side panel, just above the air cleaner. As the air enters the air cleaner, coarse trash, such as leaves, is filtered out by the air intake pre-cleaner screen located in the side panel. The air is channeled down through the center tube of the air cleaner into the oil where most of the contaminants are removed. After the air leaves the oil bath, fine dust remaining in the air is filtered by the fine wire mesh through which all air passes before entering the carburetor. With the air cleaner constructed vertically, any dirt entering the cleaner falls down through the oil and remains at the bottom of the oil cup.

Proper service of the air cleaner is of the utmost importance. Therefore, it is important that the air cleaner be kept clean at all times to prevent engine power loss and excessive fuel consumption. In extreme dirty and dusty conditions, it will be necessary to service the air cleaner more often than when operating under normal conditions. Filtered air greatly reduces wear on engine parts and will, therefore, prolong the life of the tractor.

A. Removal

1. Remove the carburetor air intake tube from the air cleaner.
2. Remove the air cleaner cover from the side of the hood and then remove the air intake screen and the funnel leading to the air cleaner, Figure 1.
3. Remove the two air cleaner attaching bolts and remove the air cleaner to a suitable location for disassembly and service.

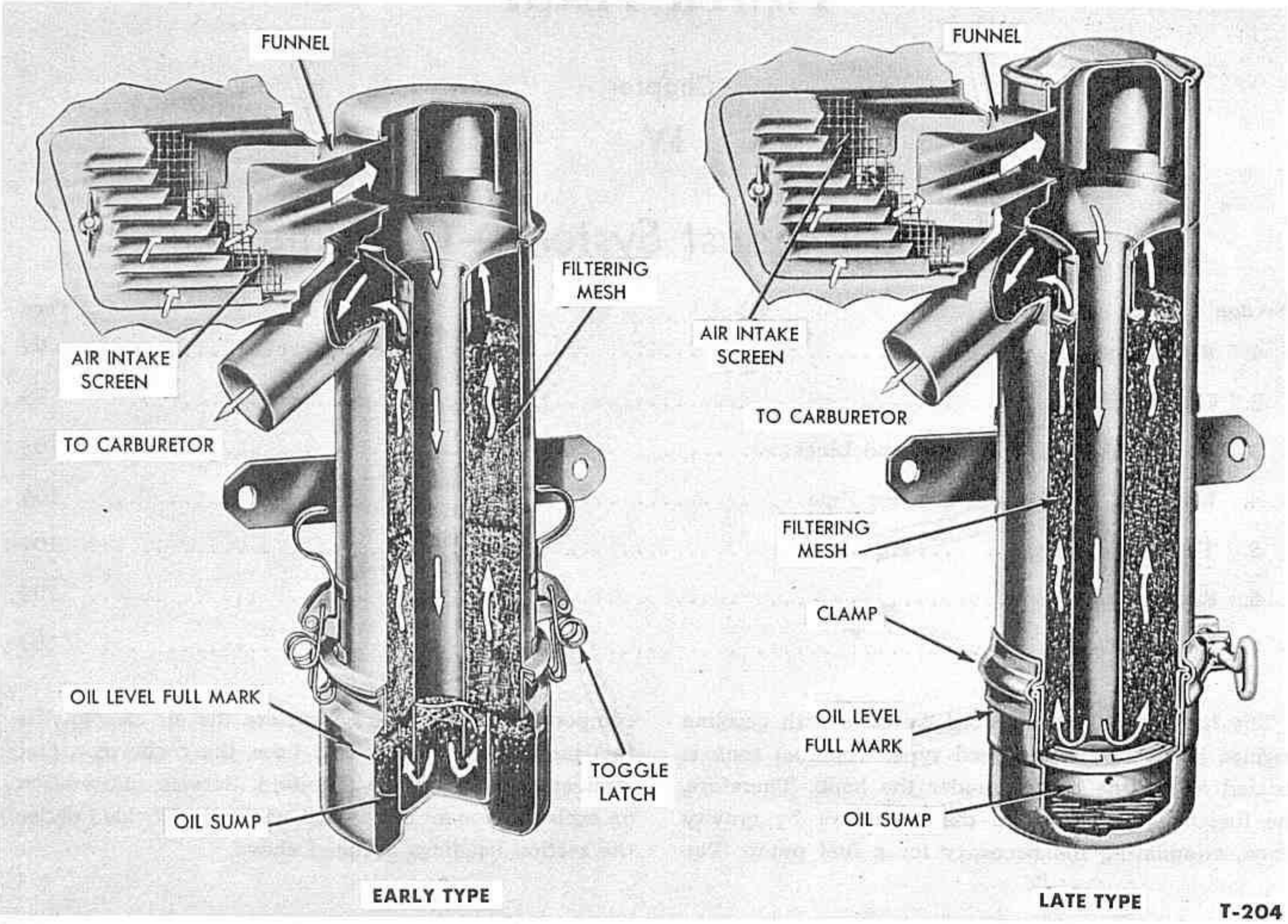

Figure 1—Carburetor Air Cleaner

NOTE: ***Keep the air cleaner in an upright position to avoid spilling oil.***

B. Maintenance

1. Unlatch the oil cup toggles or loosen the clamp, Figure 1, and remove the oil cup.
2. Remove the snap ring at the bottom of the filtering mesh (early type) and withdraw the mesh from the can. Wash the mesh in cleaning solvent and dry it thoroughly with compressed air. On later type air cleaners the mesh cannot be removed, therefore, the entire air cleaner must be soaked clean in solvent. Saturate the mesh with engine oil and install and secure it in the can with the snap ring.
3. Clean the oil cup thoroughly and fill it to the level mark with engine oil. Place the inner cup in the outer cup on the late type air cleaner.
4. Wash the air intake screen and the funnel in cleaning solvent and dry them thoroughly.

C. Installation

1. Position the air cleaner on the tractor and install the two bolts, lock washers and nuts. Tighten the bolts securely.
2. Install the funnel in the top of the air cleaner and secure it with the two sheet metal screws.
3. Install the air intake screen and the air intake cover. Tighten the cover securely.
4. Install the air tube between the carburetor and the air cleaner. Be sure the hose clamps are securely tightened.
5. Place the oil cup in position and secure it with the toggle latches or clamp.

2. CARBURETOR

The carburetor used on all Ford Tractor engines from the 1955 through the 1960 are basically the same type, with the same operating principles. The size of the main jets, however, vary depending on the size of the engine. The carburetors are the plain tube, up draft type. Interchange of carburetors on the manifold is impossible, as the carburetor stud spacing is different for each size carburetor.

A. Operation

To understand the operation of a carburetor it is necessary to bear one basic fact in mind. The only function of a carburetor is to mix air and fuel and supply that mixture to the engine in the proper amount, and at the proper time. The Ford tractor carburetor is made up of four systems, see Figures 2 through 5. These systems are: the float system, the idle system, the power fuel system, and the choke system. Each system except the float system supplies a fuel air mixture to the engine under different conditions of engine demand. Therefore, with all the systems functioning properly, the carburetor supplies the correct fuel air mixture through the entire range of engine operation.

1. The float system, as shown in Figure 2, controls the level of the gasoline in the carburetor fuel bowl, and admits fuel as necessary to maintain the proper fuel level throughout the operating range of the engine. As the fuel level lowers, the float lowers and the float valve (3), Figure 2, opens to admit more fuel to the float bowl. As the fuel reaches the operating level, the float raises, closing the float valve, which shuts off the fuel supply. Actually, during normal operation, the float assembly positions so that the inward flow and the outward flow are about even.

   The float system is a dual float mechanism, used in a float chamber or fuel bowl that almost completely surrounds the main discharge nozzle. This construction permits operation of the engine at any angle up to 45°.

2. The idle fuel system, shown in Figure 3, controls the flow of fuel at idle speed and at slow speeds until the throttle is opened wide enough to allow the power system to operate.

   When the throttle plate (6), is in the idle position, it is slightly open, with the edge of the plate between the primary and secondary idle orifices (7) and (8). With the plate in this position, the air pressure at the primary orifice is lower than the air pressure in the fuel bowl chamber, due to manifold vacuum at the primary orifice. Therefore, fuel is forced from the fuel bowl into the idle passage (10), Figure 3. As the fuel travels through the idle fuel passage, it passes through the idle jet (11), to the point where it is combined with air entering through the idle fuel adjustment needle seat (12). The fuel is mixed with air again when it passes the secondary idle orifice as it travels through the idle fuel passage. The mixture that emerges from the primary idle orifice is rich, however, it is reduced to the correct proportion by the air passing the throttle plate.

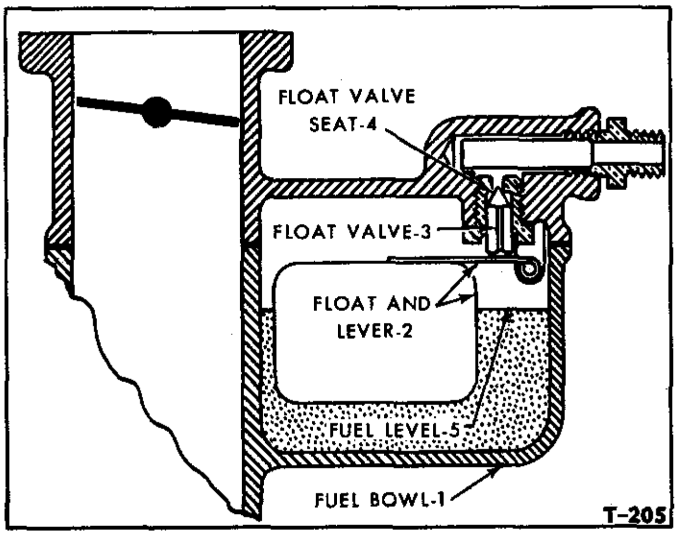

Figure 2—Float System

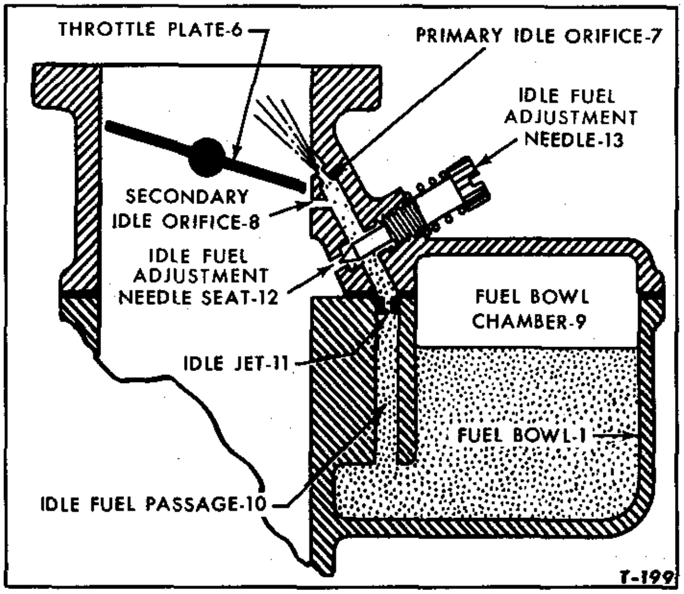

Figure 3—Idle Fuel System

As the throttle plate is slowly opened from the idle position, the secondary idle orifice is gradually subjected to greater manifold vacuum, and as the manifold vacuum increases, the orifice ceases to bleed air to the idle fuel passage. Instead, fuel is fed from the idle fuel passage through the secondary idle orifice to the engine. With the throttle open wider than idle, a greater amount of air is admitted, necessitating a greater amount of fuel than can be supplied through the primary idle orifice. The additional fuel supplied through the secondary idle orifice maintains the correct fuel air ratio for the engine.

As the throttle is opened wider, the idle fuel delivery begins to fade and the power fuel system starts to function.

3. The power fuel system, shown in Figure 4, supplies fuel to the engine in the speed ranges beyond idle and slow speed.

   As engine speed is increased, the air flow through the venturi (17), Figure 4, is increased. The increased air flow creates a vacuum at the nozzle tip (14). The pressure then is lower at the nozzle than it is in the fuel bowl chamber (9), Figure 3, and the accelerating well (16), Figure 4. Fuel, therefore, flows from the fuel bowl, through the main adjustment needle and seat assembly (19) and out the nozzle (14) and into the air stream at the venturi. At the same time, the fuel in the accelerating well is forced through the nozzle air bleeds (15) in the nozzle. However, due to the size of the power jet and the restriction at the main adjustment needle seat, the fuel in the accelerating well is soon exhausted, and air enters the accelerating well through the nozzle air vent (20), Figure 4. The amount of air that can enter is limited by the size of the nozzle air vent. This air helps to atomize the fuel passing through the nozzle, and it helps to regulate the rate of discharge of the fuel fed from the accelerating well during acceleration. It also provides the correct mixture proportions for full throttle operation. When the throttle plate is opened suddenly to the wide open position, the fuel in the accelerating well is forced out through the nozzle air bleeds very rapidly, providing the extra rich mixture the engine needs to meet the sudden load. When the throttle is closed again, fuel fills the accelerating well, ready for the next acceleration.

4. The function of the choke plate is to restrict the air flow into the carburetor which causes a higher vacuum on the discharge nozzle, giving a richer mixture for starting purposes. The choke plate and choke system are shown in Figure 5. A small movement in the choke plate causes a great change in the fuel air mixture.

   The relief valve opens and then closes automatically depending on engine load and speed.

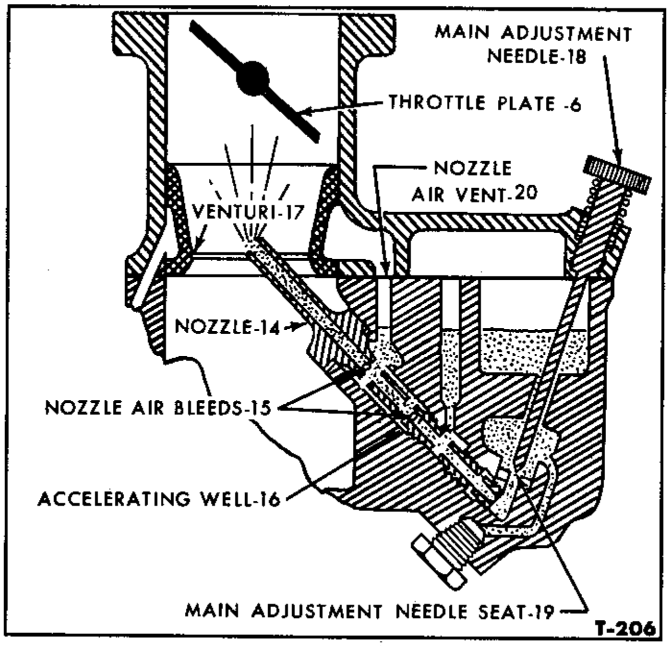

Figure 4—Power Fuel System

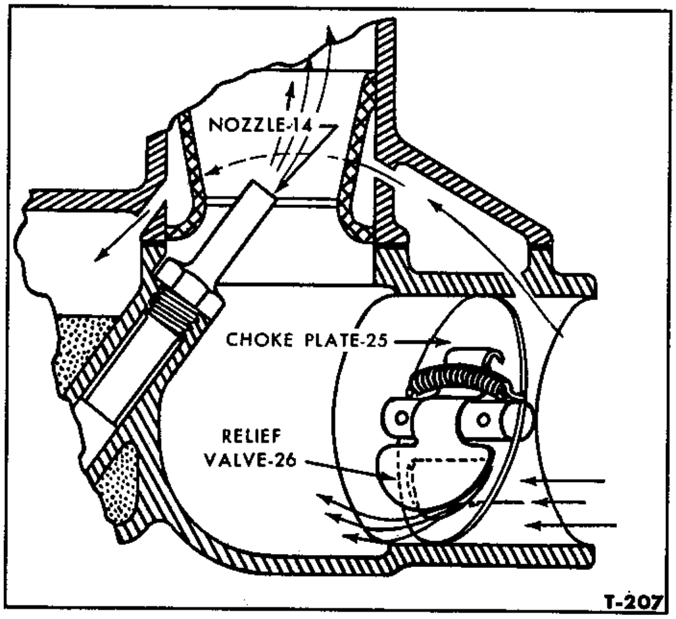

Figure 5—Choke System

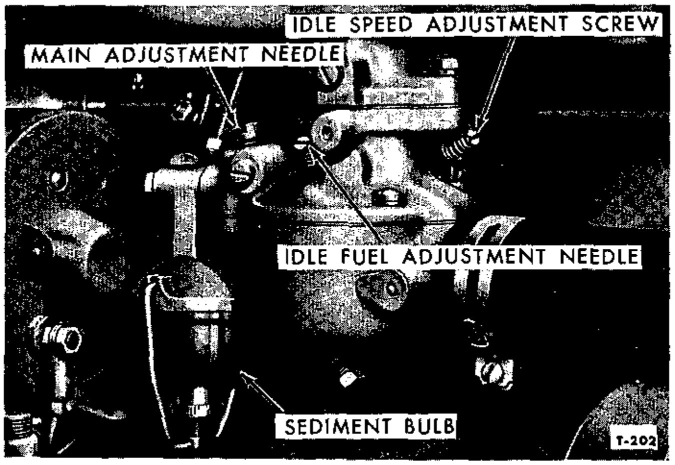

Figure 6—Carburetor Adjustments

When the engine reaches normal operating temperature, the choke plate must be fully open to assure maximum power and economy from the engine.

B. Adjustment

Three adjustments are provided on the carburetor, as shown in Figure 6. They are the main adjustment needle, the idle speed adjustment screw, and the idle fuel adjustment needle. Actually, there are three factors that control the conversion of the fuel air mixture into engine power. These factors are engine compression, ignition and correct carburetor adjustment. Correct carburetor adjustment cannot be obtained, however, unless engine compression and ignition meet specifications.

Before proceeding with the carburetor adjustment, the following preliminary steps should be performed to be sure the adjustments will be made correctly:

1. Set the idle speed adjustment screw so that the throttle plate is slightly open.
2. Make certain that the fuel tank shut-off valve is in the open position.
3. Pull the choke knob, turn on the ignition, start the engine and push the choke knob in until the engine runs smoothly.
4. After the engine has reached normal operating temperature, be sure the choke knob is pushed all the way in, and proceed as follows:
   a. For the initial setting, before the engine is started, turn the idle fuel adjustment needle, Figure 6, in (clockwise) until it is seated lightly, then back it off approximately one turn. Start the engine and turn the idle fuel adjustment needle in (clockwise) until the engine begins to "roll", then back it off slowly, until the engine is running smoothly.
   b. With the hand throttle in the closed position, turn the idle speed adjustment screw, Figure 6, until the engine idle speed is 450 to 475 rpm on the Proof-Meter. On new engines it may be necessary to set the idle slightly higher to prevent stalling.
   c. The power fuel adjustment or main adjustment needle, Figure 6, initial setting, is 1-1-¼ turns open, (counterclockwise).

      The final adjustment should be made in the field. With the engine running at governed speed under full load, turn the adjustment needle in (clockwise) after the engine power just starts to drop off, then turn the screw out (counterclockwise) until the power picks up and the engine runs smoothly.

C. Removal

1. Turn the fuel tank shut-off valve to the "OFF" position.
2. Loosen the air intake tube clamps at the carburetor and pull the hose off the carburetor.
3. Disconnect the fuel line at the sediment bowl.
4. Disconnect the governor and throttle rod linkage at the carburetor.
5. Remove the two nuts and lock washers that attach the carburetor to the manifold. Remove the carburetor and clean the gasket mounting surfaces.
6. Clean the outside of the carburetor with cleaning solvent to permit an external examination for damages or defects.

D. Disassembly

1. Loosen the bail wire and remove the sediment bowl.
2. Remove the fuel filter screen from the top of the sediment bowl cover.
3. Remove the main adjustment needle assembly.
4. Remove the carburetor bowl, screws, and lock washers. Separate the cover from the bowl.
5. Remove the float, bowl gasket, venturi, and float valve from the cover, Figure 7. Remove the float valve seat and gasket with a screwdriver that is wide enough to engage both slots in the valve seat.

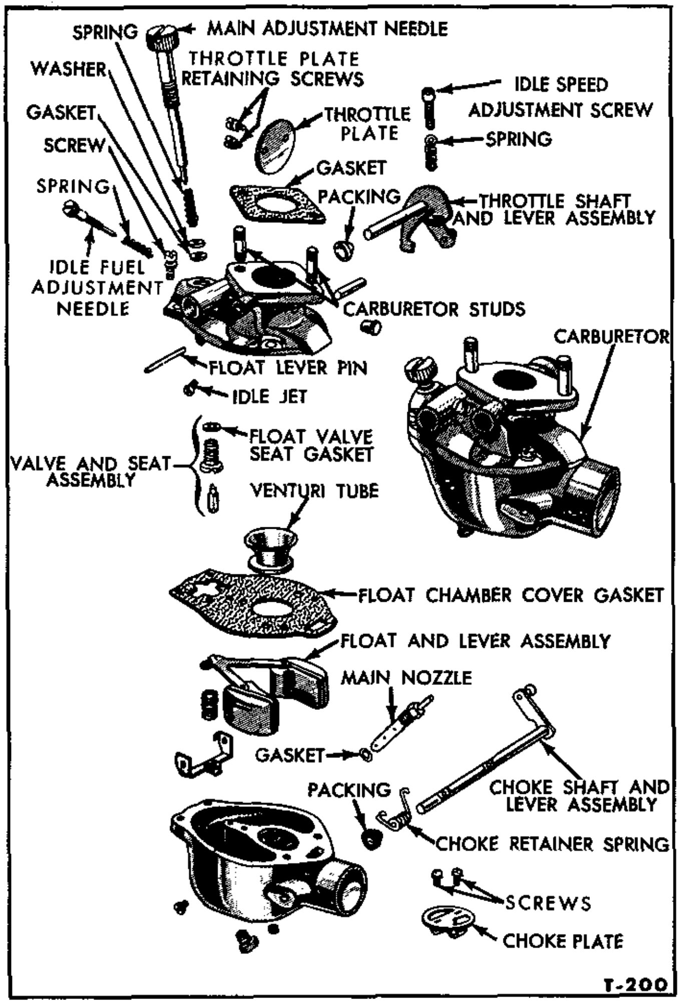

Figure 7—Carburetor Disassembled

NOTE: *Later model carburetors incorporate a float valve support spring and support, Figure 7.*

6. Remove the idle jet.
7. Remove the idle fuel adjustment needle and spring.
8. Mark the throttle plate so it can be reassembled in the same position, then remove the throttle plate screws, throttle plate and throttle shaft and lever assembly.
9. Remove the throttle shaft packing and retainer with a small punch.
10. Remove the main discharge nozzle and gasket.
11. Remove the drain plug from the bottom of the fuel bowl.
12. Remove the choke plate screws, choke plate, and the shaft and lever assembly.
13. Remove the choke shaft packing retainer and the packing.

E. Inspection and Cleaning

1. Clean all parts with a good solvent. Be sure all channels and orifices are clean. Discard jets showing signs of wear or corrosion.

   IMPORTANT: *Never use a wire or small drill to clean out orifices. Even a small change in the size of a hole will affect carburetor operation.*

2. Discard the float valve and seat if they are grooved or corroded. Always use an entire float valve and seat assembly, as they are serviced in matched sets.
3. Discard the idle fuel adjustment needle if it is grooved or corroded.
4. Inspect the throttle shaft and lever assembly for wear. If the shaft is loose in the bore, a new assembly should be used.
5. Inspect the carburetor fuel bowl and bowl cover for cracks or distortion. Check the float for leaks, cracks or distortion.

F. Assembly

A disassembled view of the carburetor is shown in Figure 7.

1. Install the retainer and new packing in the fuel bowl. Tap the retainer lightly until it is flush with the casting.
2. Install the throttle shaft in the bowl making sure the idle speed adjustment screw is to the rear of the stop. Place the throttle plate in operating position and install the screws and lock washers. The angle number of the throttle plate should face toward the rear of the carburetor.
3. Install the idle jet, Figure 7.
4. Install the idle fuel adjustment needle and spring. Turn the needle in until it just contacts the seat, then back it off one turn for the initial adjustment.
5. Install a new gasket and the float valve seat using a screwdriver that is wide enough to contact both slots in the seat. Install the float valve, and fuel bowl gasket, then install the float and lever assembly.

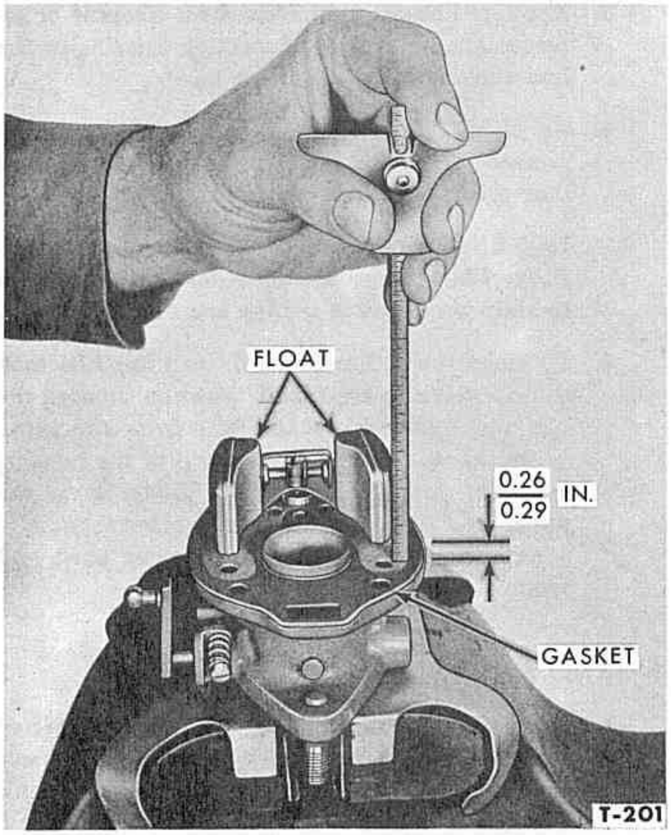

Figure 8—Checking Carburetor Float Level

NOTE: ***Install the float support spring and support if the carburetor is so equipped, Figure 7.***

6. Adjust the float so that it measures 0.26-0.29" from the gasket to the nearest edge of the float, as shown in Figure 8. The float is adjusted by bending the hinge. Use caution when bending the hinge to avoid damaging the mounting bracket.
7. Install the retainer and packing in the carburetor bowl. Slip the shaft through the bore, then install the choke plate and retaining screws, Figure 7.
8. Be sure the choke return spring is properly hooked over the lever and on the stop provided on the side of the carburetor. Position a new gasket on the main nozzle and install the nozzle in the carburetor body.
9. Invert the throttle body and install the fuel bowl. Install the retaining screws and tighten them to 36 in. lbs. torque.
10. Use new gaskets and install the sediment bowl cover on the carburetor.
11. Replace the fuel filter in the top of the sediment bowl. Use a new gasket and secure the sediment bowl in place with the bail wire and nut. Tighten the bail securely.
12. Install the drain plug in the bottom of the carburetor.

G. Installation

1. Use a new carburetor mounting gasket and hold the carburetor in place on the manifold. Install the two lock washers and nuts and tighten them to 12-16 ft. lbs. torque.
2. Connect the governor and throttle rod linkage at the carburetor.
3. Connect the fuel line at the sediment bowl.
4. Install the air intake tube hose on the carburetor and tighten the hose clamps securely.
5. Turn the fuel tank shut-off valve to the "ON" position.
6. Start the engine and allow it to run until it reaches normal operating temperature. Adjust the carburetor as outlined in paragraph B. page 101.

3. FUEL TANK, SEDIMENT BOWL AND LINES

The fuel tank is located directly under the hood, above the engine. The fuel outlet to the sediment bowl and carburetor is located in the bottom of the tank, at the center. The fuel shut-off valve is also incorporated in the fuel tank outlet fitting. The fuel line runs from the outlet fitting to the sediment bowl which is mounted on the front of the carburetor, see Figure 6.

The fuel tank filler is located in the center of the tank, under the hood top center panel, which is hinged for easy access to the filler.

Refer to the Electrical Section for information on the fuel gauge tank unit.

A. Fuel Tank Removal

1. Remove the hood assembly.
2. Turn the fuel shut-off valve to the "OFF" position.

3. Disconnect the fuel line at the fuel shut-off valve fitting.
4. Remove the fuel tank attaching bolt from each rear corner of the fuel tank.
5. Loosen the nut that attaches the front of the fuel tank to the center of the fuel tank front support bracket.
6. Disconnect the wire from the fuel gauge at the tank.
7. Slide the fuel tank approximately one inch to free it from the front mounting bolt, then lift it from the tractor.

B. Fuel Tank Cleaning

1. Water caused by normal condensation, accumulates in the fuel tank when allowed to stand low or empty for a period of time (usually over night). Therefore, it is a good practice to fill the tank to capacity at the end of each day of operation to prevent moisture laden air from forming water, rust and gum formations. Long periods of tractor storage may also cause gum formations in the tank.
2. If it is necessary to clean the tank, drain the fuel completely and remove the shut-off valve fitting.
3. Wash the interior of the tank thoroughly with a mixture of alcohol and acetate or any other suitable solution. Disassemble the fuel shut-off valve and clean it thoroughly. Dry the tank thoroughly, then reassemble the shut-off valve and mount it on the tank.

C. Sediment Bowl and Fuel Lines

1. The sediment bowl is located at the front of the carburetor and is provided for the purpose of trapping condensation or other contaminants that may flow through the fuel line from the fuel tank.
2. The fuel line can be removed for cleaning or replacement by first disconnecting the line at the fuel tank and the sediment bowl.
3. To clean the fuel line, blow it out with compressed air. When replacing a fuel line, be sure that the connections are tight and do not leak.

   NOTE: ***Tighten fuel line connections carefully. The fittings are brass and it is possible to strip the threads if they are over-tightened.***
4. To clean the sediment bowl, turn the fuel tank shutoff valve to the "OFF" position. Loosen the bail nut and remove the bail from the bowl. Withdraw the bowl from the top of the housing and also remove the screen. Clean both the screen and the bowl and then replace them. Use a new gasket between the sediment bowl and sediment bowl housing.

D. Fuel Tank Installation

1. Place the fuel tank in position on the tractor making sure the carriage bolt on the fuel tank front support bracket engages the fuel tank bracket.
2. Install the bolt and lock washer at each rear corner of the tank.
3. Tighten the nut at the fuel tank front support bracket.
4. Insert the oil gauge line in the clip at the right rear of the fuel tank.
5. Connect the wire to the terminal on the fuel gauge tank unit.
6. Connect the fuel line at the fuel shut-off valve fitting and turn the fuel shut-off valve to the "ON" position. Be sure that there are no fuel leaks.
7. Install the hood assembly.

4. MANIFOLD, MUFFLER AND EXHAUST PIPE

The intake and exhaust manifolds are an integral unit on Ford Tractors with gasoline or LP-Gas engines. The manifold and exhaust systems are shown in Figures 9 and 10. A vertical or horizontal exhaust system is available on all models. All mufflers mount directly on the exhaust manifold for convenience in replacing.

MANIFOLD

A. Removal

1. Close the fuel tank shut-off valve under the tank.
2. Remove the two bolts, nuts and lock washers from the muffler inlet elbow and disconnect it from the manifold.

3. Disconnect the fuel line at the carburetor sediment bowl and the air intake tube at the carburetor.
4. Remove the six nuts and lock washers from the manifold mounting studs.
5. Remove the manifold assembly and the manifold gasket from the engine.

B. Disassembly, Inspection and Cleaning

If the manifold has been in use for some time, deposits of gum may be present in the intake manifold. These deposits affect the air-fuel mixture flow characteristics and may cause poor engine performance. It is good practice to clean the manifold thoroughly every time it is removed from the engine.

1. Remove the two nuts and lock washers from the carburetor mounting studs and separate the carburetor from the manifold. Be sure the carburetor mounting gasket is also removed.
2. Examine the manifold for cracks or defects such as warpage, or chips out of the mounting surface. Always replace a warped or cracked manifold. Soak the manifold in a good solvent to loosen gum deposits, then dry it thoroughly.
3. Place a new carburetor mounting gasket on the carburetor mounting studs, then install the carburetor and the nuts and lock washers. Tighten the nuts securely.

C. Installation

Be sure all the old gasket material is cleaned off the mounting surfaces on the manifold and cylinder head. Always use new manifold gaskets whenever the manifold is removed.

1. Position the manifold gasket, and the manifold, over the mounting studs.
2. Install the six nuts and lock washers and tighten the center nuts first. Then alternately tighten the remaining nuts toward each end to 40-50 ft. lbs. torque.
3. Place a new gasket between the manifold and the muffler inlet elbow and install the two bolts. Tighten the bolts to 40-50 ft. lbs. torque.
4. Connect the fuel line at the carburetor sediment bowl and the air intake tube at the carburetor. Open the fuel tank shut-off valve and check for leaks at the carburetor.

MUFFLER, OUTLET AND EXTENSION PIPE REPLACEMENT

A. Horizontal Exhaust System

1. Remove the bolt that attaches the muffler outlet pipe extension bracket and clamp to the center housing, see Figure 9.
2. Remove the bolt that attaches the outlet and extension pipe clamp bracket to the engine plate located at the front of the transmission. Remove the bolt that attaches the clamp to the pipes.
3. Separate the extension pipe from the outlet pipe.
4. Remove the bolt that attaches the muffler front clamp to the muffler outlet pipe support.
5. Separate the muffler outlet pipe from the muffler.
6. Remove the two bolts that attach the muffler front support to the fuel tank front support and remove the muffler front support.
7. Remove the clamp that secures the muffler to the muffler inlet flange elbow.
8. Separate the muffler from the elbow.
9. Slip the muffler onto the muffler inlet flange elbow, Figure 9. Secure the muffler to the elbow with the rear clamp.
10. Secure the muffler outlet pipe support to the fuel tank front support with the two attaching bolts.
11. Slip the muffler front clamp on the outlet pipe. Install the muffler outlet pipe on the muffler. Secure the front clamp to the muffler front support with a bolt, lock washer and nut.
12. Slip the extension pipe onto the outlet pipe, then install the attaching clamps and brackets.

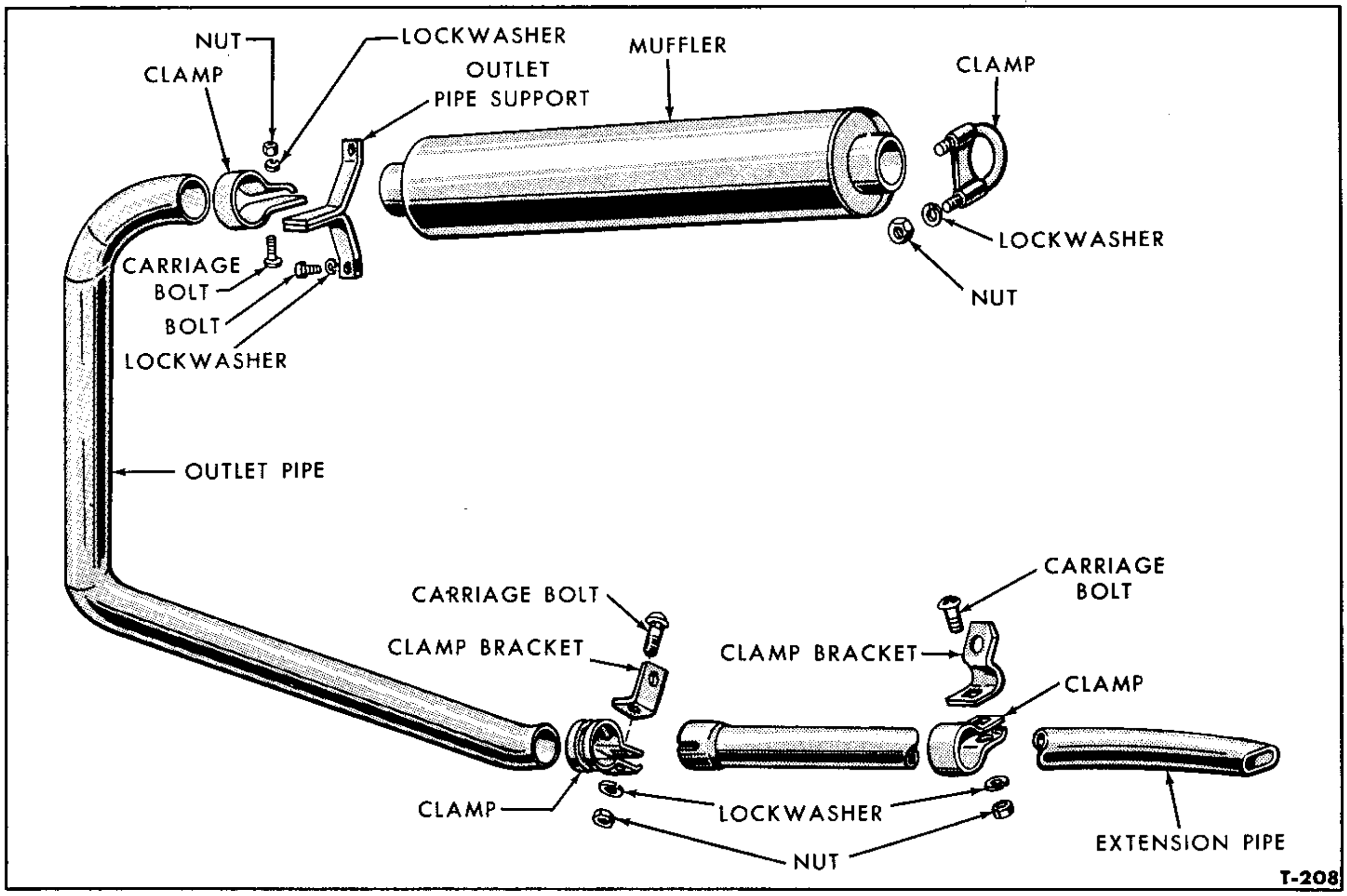

Figure 9—Horizontal Exhaust System

B. Vertical Exhaust System

1. Loosen the clamp bolt that secures the outlet pipe to the muffler outlet pipe support bracket, Figure 10. Remove the outlet pipe.
2. Remove the rain cap from the pipe if so equipped.
3. Remove the bolt that secures the muffler outlet elbow to the muffler.
4. Remove the two bolts and spacer that attach the muffler outlet elbow to the fuel tank front support. Pull the elbow off the muffler.
5. Remove the bolt from the muffler rear clamp. Pull the muffler off the muffler inlet elbow.
6. Position the muffler rear clamp on the rear of the muffler, Figure 10. Slide the muffler onto the inlet elbow as far as possible. Install and tighten the muffler rear clamp bolt.
7. Position the muffler front clamp on the muffler. Slip the muffler outlet support elbow onto the muffler. Install the two support attaching bolts and spacer. The spacer and largest attaching bolt are installed at the lower end of the support. Tighten the muffler front clamp.
8. Slip the outlet pipe and clamp onto the elbow and tighten the clamp.
9. Secure the raincap to the upper end of the outlet pipe if so equipped.

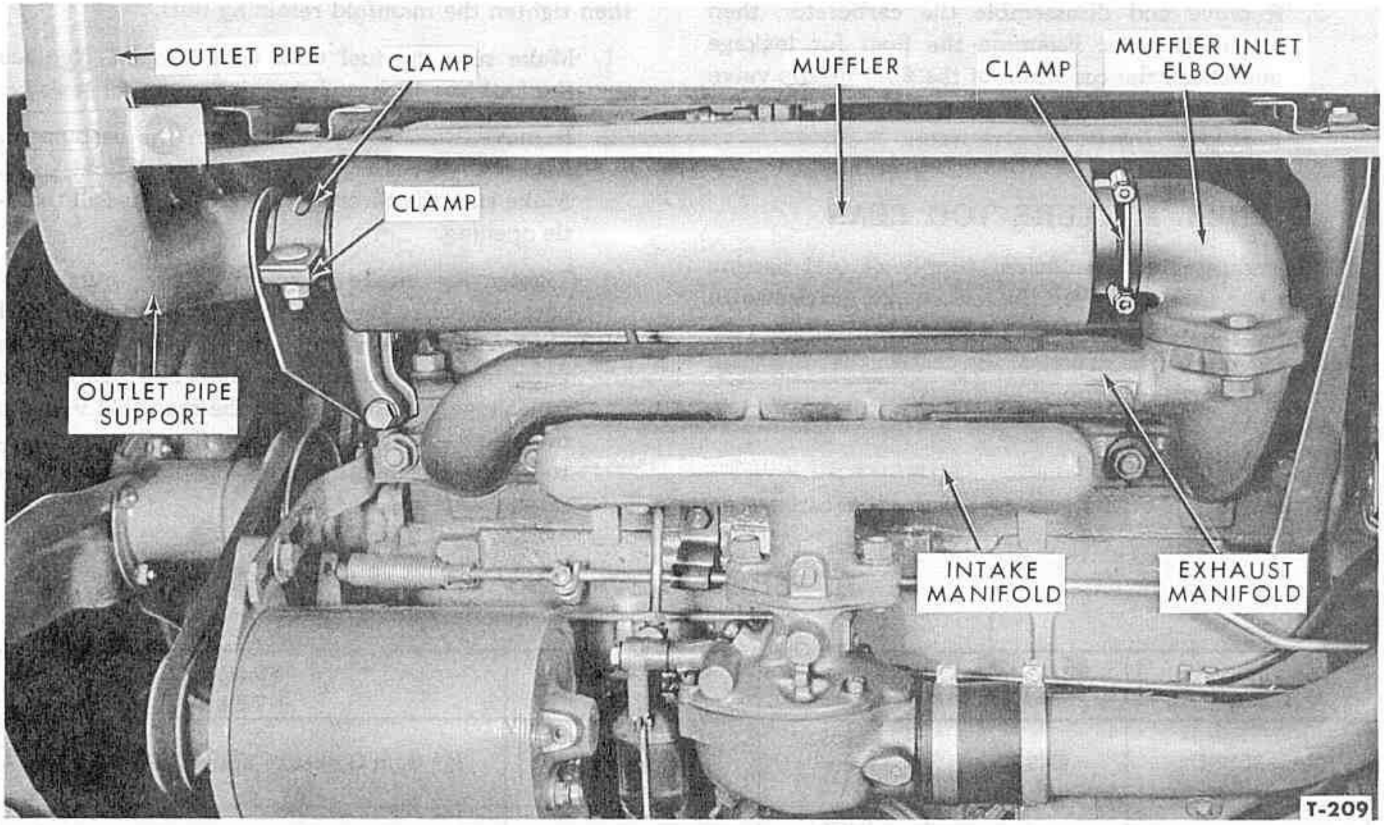

Figure 10—Vertical Exhaust System

5. TROUBLE SHOOTING

The fuel system consists of a tank, carburetor, manifold and the various connecting lines. Dirt and other foreign materials should be kept from entering this system.

As a rule, the carburetor does not fail suddenly but progressively impairs engine performance.

FUEL NOT REACHING THE CARBURETOR

A clogged or broken fuel line is the most common cause of this trouble.

A. Preliminary Instructions

Check the supply of fuel in the tank. Make sure the tank vent in the cap is open.

1. Be sure the fuel tank shut-off valve is operating properly. Remove the fuel line and blow it out. Clean the fuel sediment bowl and screen.
2. Drain any accumulation of water or sediment from the tank. In freezing weather, water in the tank will freeze and will prevent fuel from entering the fuel line.

CARBURETOR FLOODS

Flooding is caused by a sticking choke or float valve or by the carburetor float being set too high. On hot days, fuel may "percolate" from the carburetor bowl into the intake manifold while the engine is not operating. Dirt may be lodged under the float needle, holding it open.

A. Preliminary Instructions

In addition to the engine running unevenly, a strong odor of gasoline usually is present when the carburetor is flooded. If the carburetor flooding is due merely to overchoking, open the throttle wide, then crank the engine to exhaust rich gases.

B. Procedure

Free up the choke action and inspect the float level and the condition of the float.

1. Remove the air cleaner to carburetor hose, operate the choke rod, and observe if the carburetor choke plate opens freely. If the choke action is faulty, make necessary corrections.

2. Remove and disassemble the carburetor, then clean all parts. Examine the float for leakage and check the condition of the float needle valve and seat. Make repairs as required and set the float level. Install the carburetor.

FUEL MIXTURE TOO LEAN

This indicates an insufficient supply of fuel passing through the carburetor for the volume of air drawn in by the engine. An obstructed fuel line or a leaking intake manifold may be the cause. Make certain that the main adjustment needle is properly adjusted.

A. Procedure

Clean out the fuel line and clean the carburetor, then tighten the manifold retaining nuts.

1. Make sure the fuel tank vent is open. Replace the fuel line if there is any indication of leakage.
2. Remove, disassemble, and clean the carburetor. Make all necessary repairs. Set the float level. Make sure the throttle linkage permits full throttle opening.
3. Tighten the intake manifold bolts or nuts. Connect a vacuum gauge to the intake manifold, and observe the reading as the engine idles. If the vacuum is lower than normal, it is probably due to leakage. Points at which the manifold vacuum may leak are: Intake Manifold gasket, carburetor mounting flange gasket or a cracked or loose intake manifold.

6. SPECIFICATIONS

Carburetor

Part Number	Idle Jet Part No.	Idle Jet Size	Main Metering Jet Size	Float Setting
EAE-9510-C	9N9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
EAE-9510-D	9N9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
EAF-9510-E	9N-9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
EAF-9510-G	9N9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
310746	9N9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
310015	9N9596	0.025 0.026	0.081" Drill	¼" from Gasket to nearest edge of float
312954	9N9596	0.025 0.026	No. 49 Drill	¼" from Gasket to nearest edge of float
312955	9N9596	0.025 0.026	0.081" Drill	¼" from Gasket to nearest edge of float

Fuel Tank

Capacity	Series 501 through 601	Series 701 through 901
Full	11 Gallons	14 Gallons

Torque Limits:

Throttle Body to Fuel Bowl	36 In. Lbs.
Manifold to Cylinder Block	40-50 Ft. Lbs.

7. SPECIAL TOOLS

A vacuum gauge will be helpful in making carburetor adjustments and diagnosing high fuel consumption.

Part ONE

POWER PLANT

Chapter
V

Fuel and Exhaust System — Diesel

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3 Bleeding and Flushing the Fuel System 110
4 Idle and High Speed Adjustments 111
5 Fuel Filter 112
6 Fuel Injectors 113
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8 Manifold, Muffler and Outlet Pipe 120
9 Trouble Shooting 122
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1. AIR CLEANER

The air cleaner assembly is of the oil bath type and functions in the same manner as those used on Ford Gasoline Tractors. The assembly is attached directly to the intake manifold and receives its air supply via an inlet tube, which is connected to the pre-cleaner screen and louvered cover assembly on the left side hood panel.

A. Removal

1. Loosen the hose clamp that secures the hose to the air cleaner.
2. Carefully release the oil bath tray straps and remove the tray and gasket as shown in Figure 1.

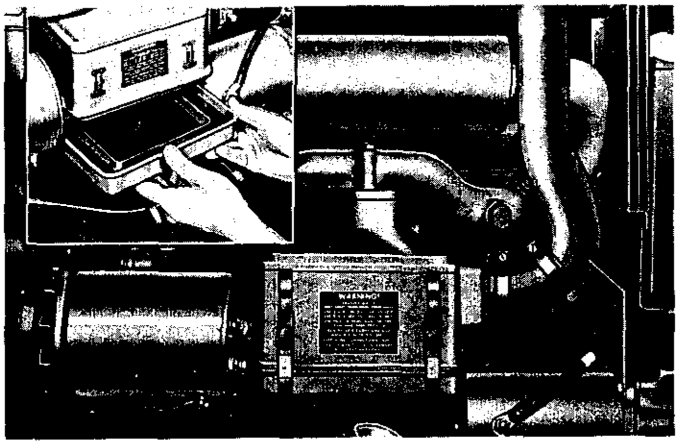


Figure 1—Air Cleaner Maintenance

3. Remove the two bolts and lockwashers that attach the air cleaner to the intake manifold. Remove the housing and gasket.

B. Air Cleaner Service

1. Clean the oil bath tray thoroughly in cleaning solvent. Remove all traces of gasket material.
2. Immerse the air cleaner assembly in clean diesel fuel, flush and drain thoroughly. Dry the filter material with compressed air.

   CAUTION: ***Do not use any lubricant other than specified. Light weight engine oils can be sucked into the firing chambers and cause a run-away engine.***

C. Installation

1. Position a new gasket on the intake manifold. Secure the air cleaner housing to the manifold with two bolts and lockwashers.
2. Fill the tray to the proper level with same weight oil as used in the engine crankcase.
3. Install the tray and secure the straps.
4. Secure the hose in place with the clamps.

2. FUEL TANK

A. Removal

1. Disconnect the battery ground cable from the right side of the tractor.
2. Remove the hood assembly.
3. Turn the fuel shut-off valve to the "OFF" position. Disconnect the fuel line from the fuel filter. Disconnect the fuel return line from the forward end of the tank.
4. Place a piece of wood across the top of the battery to prevent the tank from accidentally contacting the post or straps. Remove the bolt and lockwasher that attaches the tank to each side of the fuel tank rear support.
5. Loosen the nut that attaches the fuel tank to the front support.
6. With an assistant, slide the tank back approximately one inch to free it from the front mounting bolt, then lift it from the tractor. Disconnect the fuel line from the tank.

B. Cleaning

1. Water caused by normal condensation, accumulates in the fuel tank when allowed to stand low or empty for a period of time (usually overnight). Therefore, it is a good practice to fill the tank to capacity at the end of each day of operation to prevent moisture laden air from forming water, rust and gum formation. Long periods of tractor storage may also cause gum formations in the tank.
2. If it is necessary to clean the tank, drain the fuel completely and remove the shut-off valve fitting.
3. Wash the interior of the tank thoroughly with a mixture of alcohol and acetate or any other suitable solution. Disassemble the fuel shut-off valve and clean it thoroughly. Dry the tank thoroughly, then reassemble the shut-off valve and mount it on the tank.

C. Installation

1. Connect the fuel line to the fuel shut-off valve but do not tighten the line fitting. With an assistant, position the tank on the support brackets making sure the tank front mounting bracket engages the carriage bolt at the fuel tank front support.
2. Install the two rear attaching bolts. Tighten the front mounting bolt.
3. Connect the fuel line to the fuel filter, and tighten both fittings. Connect the fuel return line to the front of the fuel tank.

   NOTE: ***Tighten fuel line connections carefully. The fittings are brass and it is possible to strip the threads if they are over-tightened.***

4. Install the hood assembly.
5. Turn the fuel shut-off valve to the "ON" position. Remove the wood from the top of the battery. Connect the battery ground strap to the right side of the tractor.
6. Bleed the fuel system as detailed in Section 3 below.
7. Fill the air cleaner oil bath tray to the oil level mark with the specified engine oil. Using a new oil bath tray gasket, secure the tray to the air cleaner.
8. Connect the air inlet tube to the air cleaner and secure with the hose clamp.

3. BLEEDING AND FLUSHING THE FUEL SYSTEM

A. Bleeding the Fuel Filter

1. Open the fuel tank shut-off valve at the bottom of the tank.
2. Open the drain cock at the bottom of the fuel filter base, Figure 4. Close the drain cock when the fuel begins to flow.
3. Open the bleed screw at the top of the filter cover two turns to release any air that may be trapped. After a solid flow of fuel appears, tighten the bleed screw.

   IMPORTANT: ***Never open the bleed screw when the engine is running as air will be sucked into the system.***

B. Flushing the Injectors and Pressure Lines

1. Disconnect the pressure line from each injector. Move the pressure lines 1/32-1/16" away from the injectors.

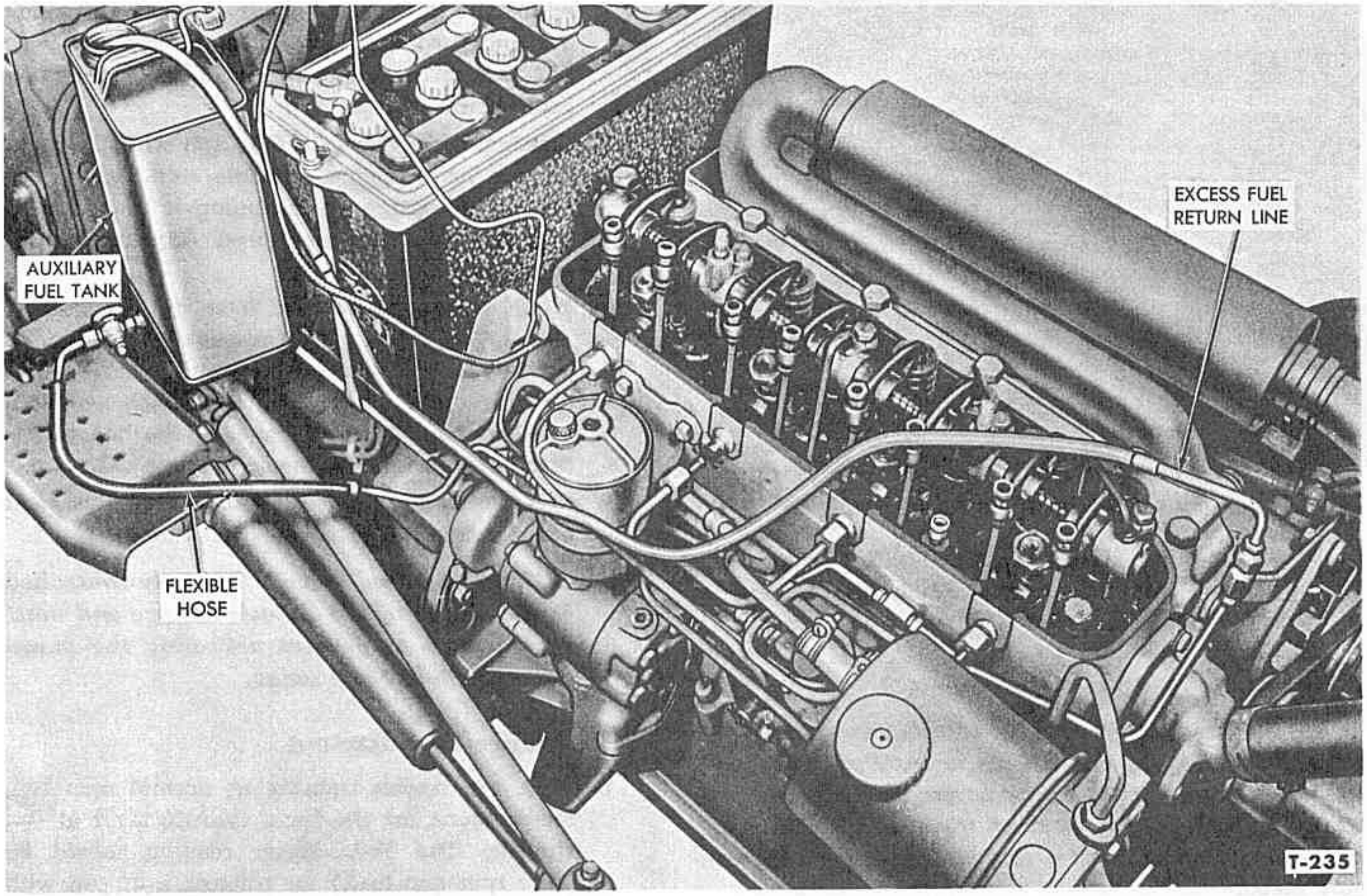


Figure 2—Flushing Fuel System

2. Crank the engine to direct fuel from each pressure line into its respective injector inlet and flush away any dirt or foreign material, Figure 2.
3. After the lines and injectors have been flushed, connect the lines to the injectors, tighten and then back off the connectors two turns each.

NOTE: ***It is not necessary to remove the fuel tank to bleed the fuel system.***

C. Final Bleeding and Engine Starting

1. Set the hand throttle for idle position.
2. Crank the engine with the starter and observe the pressure line connection to each injector. When fuel is emitted, tighten the connection.

NOTE: ***The fuel injector pump is self-bleeding; therefore, it requires no attention when bleeding the system.***

4. IDLE AND HIGH SPEED ADJUSTMENTS

The fuel injection pump is provided with engine idle and high speed adjusting screws, shown in Figure 3. In addition, the throttle linkage may be adjusted to provide for the correct amount of dead travel for the hand throttle lever. Each of these adjustments are important to the operating efficiency of the Ford Diesel Tractor and should be checked whenever the tractor is serviced.

A. Idle Speed Adjustment

1. Start the engine and allow it to reach normal operating temperature, 180° F.
2. Position the hand throttle lever for low idle (at the stop) which should read 600 rpm on the Proof-Meter.
3. Adjust the idle speed at 600 rpm as follows:
   a. Back off the jam nut on the idle speed adjustment screw, Figure 3, and use an Allen wrench to turn the screw.
   b. Turn the screw in to increase engine rpm or out to decrease engine rpm.

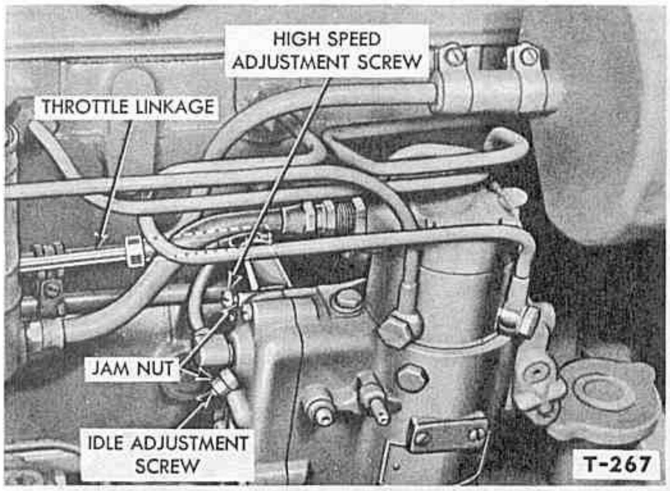


Figure 3—Idle and High Speed Adjustments

c. Lock the screw in position with the jam nut after an idle speed of 600 rpm has been obtained.

B. Throttle Linkage Adjustment

The throttle linkage must be adjusted any time a replacement pump or new linkage is installed. The linkage should also be checked for proper length in relation to the hand throttle lever dead travel at the idle position, when making normal service adjustments for engine speed.

1. With the engine running, set the hand throttle lever to the idle stop and disconnect the throttle linkage at the injection pump operating lever.
2. Rotate the pump operating lever rearward to its idle position.

   NOTE: ***There is no idle stop on the pump operating lever. When it is at idle position, a slight drag will be felt. When the lever is moved further to override this drag, it contacts the stop and shuts off the fuel.***

3. With the pump operating lever in idle position, adjust the throttle linkage by loosening the lock nut and turn the ball cage until it aligns with the ball on the pump operating lever and then connect the linkage.
4. Check for idle speed of 600 rpm with the hand throttle lever against the idle stop. Adjust the idle speed setting at the pump if correction is required. See "A. Idle Speed Adjustment," on page 111.
5. Move the hand throttle lever off of its stop, about ¼ to ½ inch (measured at the hand throttle lever). The engine should just start to pick up speed at this position, which insures a small amount of dead travel in the hand lever throttle before the engine accelerates.
6. Repeat the linkage adjustment until the hand throttle lever dead travel is established.

NOTE: ***The dead travel is entirely controlled by the length of the throttle linkage and must be obtained to prevent activating the pump governor in low idle range.***

C. High Speed Adjustment

1. With the engine running at normal operating temperature, set the hand throttle lever at full throttle. The Proof-Meter reading should be 2430 rpm (no load) for tractors equipped with five-speed or Select-O-Speed transmissions, and 2230 rpm (no load) for tractors equipped with four-speed transmissions.
2. Adjust for proper rpm maximum speed as follows:
   a. Loosen the jam nut on the pump operating lever high speed adjustment screw, Figure 3.
   b. Use a screwdriver and turn the screw "OUT" to increase engine rpm. Turn the screw "IN" to decrease engine rpm.
   c. Lock the screw in position with the jam nut after the proper adjustments have been made.

5. FUEL FILTER

The fuel filter assembly utilizes a disposal element which should be replaced after each 400 hours of operation.

A. Filter Element Removal

1. Close the fuel tank shut-off valve located at the bottom center of the tank.
2. Open the drain cock at the bottom rear of the filter base and drain the fuel into a drain pan.
3. Remove the cover assembly and filter element by turning the cover counterclockwise, Figure 4. The filter element is spring loaded and will raise from the filter base as the cover assembly is backed off. There are two element cork gaskets, one is located at the top and the other at the bottom of the element. Both gaskets and element should be discarded.

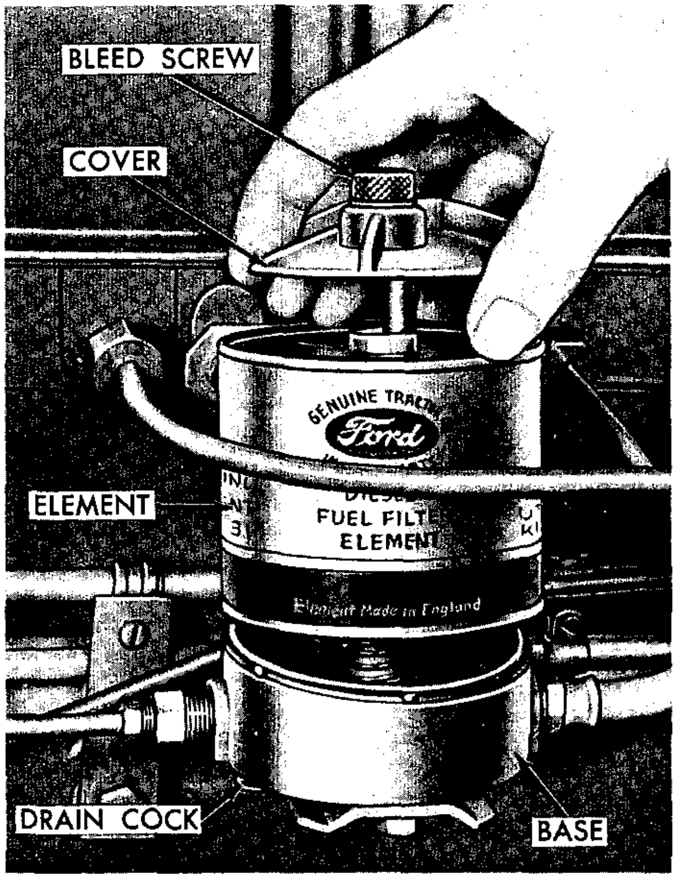


Figure 4—Servicing the Fuel Filter Element

4. Remove the rubber grommet and spring from the center post in the filter base.

B. Cleaning

1. Wipe out the inside of the filter base with a clean rag and flush with clean diesel fuel allowing the fuel to drain through the drain cock.
2. Clean the cover and bolt assembly plus the base spring, in diesel fuel.

C. Filter Element Installation

1. Close the drain cock at the bottom of the filter base.
2. Assemble the spring and a new rubber grommet on the center post of the filter base.
3. Use a new gasket at the top and bottom of the new filter element and position the element over the rubber grommet on the center post of the filter base.
4. Place the cover and bolt assembly through the center core of the element and depress the element slightly to start the bolt threads. Tighten the cover and bolt assembly. Open the fuel tank shut-off valve. Prior to starting the tractor engine, the fuel system must be bled as outlined in Section 3, page 110.

6. FUEL INJECTORS

Injector removal and installation cannot be accomplished without repositioning the push rods. When servicing the injectors, always cap off the injector inlets as well as the pump pressure lines to avoid the possibility of dirt entry, which would quickly destroy the injectors during operation.

A. Injector Removal

1. Remove the valve rocker cover and gasket. Disconnect the excess fuel return line at the top of each injector. Back off the hex nut fitting at the "tee" connection in the line to the cylinder head to remove the line, Figure 5.
2. Close the fuel tank shut-off valve located at the bottom center of the tank.
3. Wipe all dirt from the pressure line connections at the injectors and pump. Disconnect the lines from the injectors and loosen the attaching bolts at the pump. Cap off the injector inlets and the lines as well.
4. Back off the valve rocker adjusting screws two turns each to relieve valve spring tension and free the push rods from the rocker arms on both sides of the injectors as follows:
    a. Start at either the left or right side of an injector, position a ½" box wrench over the head of the valve rocker adjusting screw and lift the rocker arm sufficiently to free the push rod.
    b. Move the push rod sideways or away from the injector to be removed and release the rocker arm.
    c. Repeat the same procedure at the opposite side of the injector and move the push rod away from the injector before releasing the valve rocker arm. Repeat this operation for each injector to be removed.
5. Remove the injector mounting bolts and pull the injectors using Injector Lifting Bar, EIADDN 17098, shown in Figure 6. Screw the knurled knob assembly of the bar into the top of the

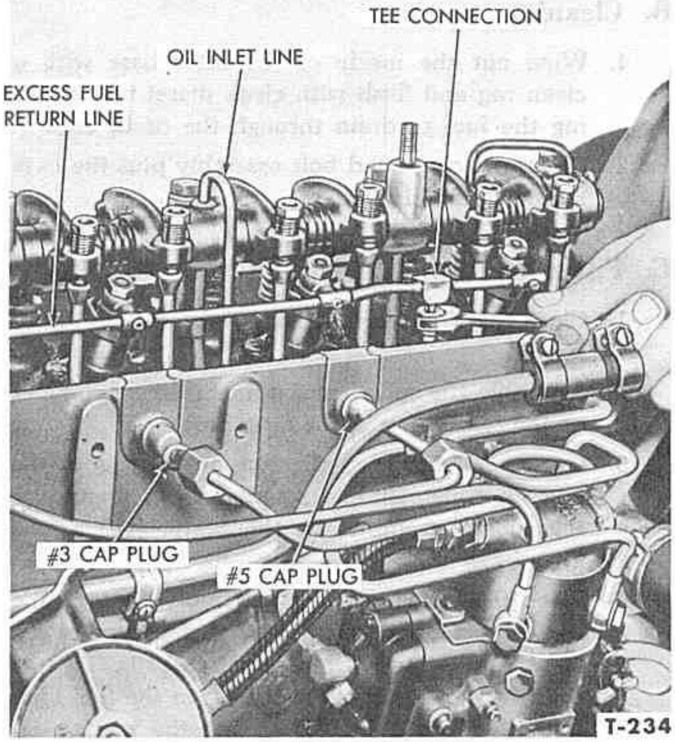


Figure 5—Removing Injector Excess Fuel Return Line

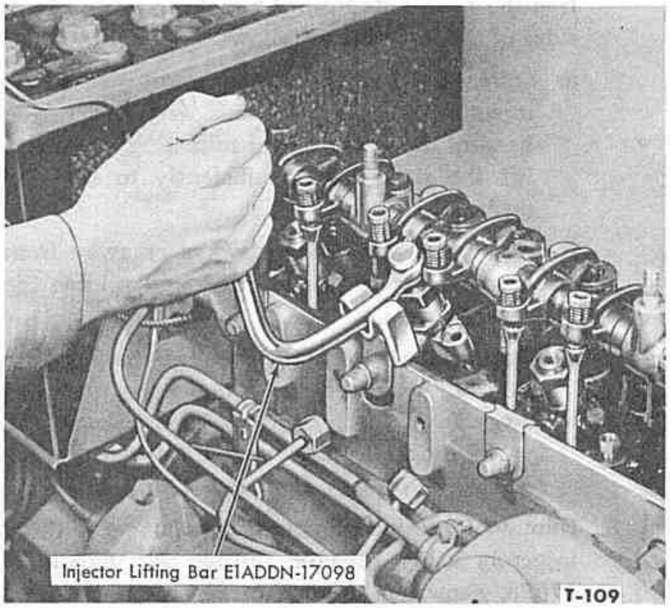


Figure 6—Removing Fuel Injectors

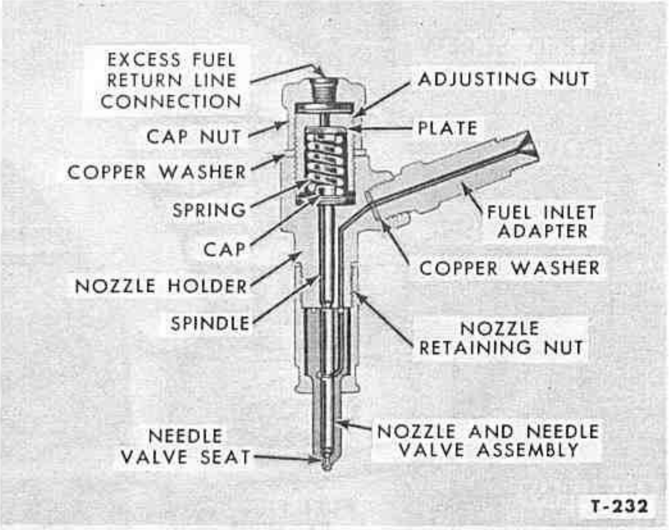


Figure 7—Fuel Injector—Sectional View

injector, finger tight, and press steadily downward on the handle to remove the injector. Make certain that the legs of the bar bear against the flange on the cylinder head rather than on the thick rubber injector seal. Check the injector bores in the cylinder head for seat washers that may have remained in position when the injectors were removed.

6. Remove any injector seat washers that remain in the bores with a wire hook. If the washers are stuck due to carbon deposits, try the following method of removal:

   a. Procure a new seat washer and a screwdriver (not over 8½" in length) with a blade that is slightly wider than the I.D. of of the washer.

   b. Grind the edges of the blade to a taper that will permit the blade to protrude through the washer I.D. no more than ⅛ inch.

   c. Place the screwdriver into the injector bore

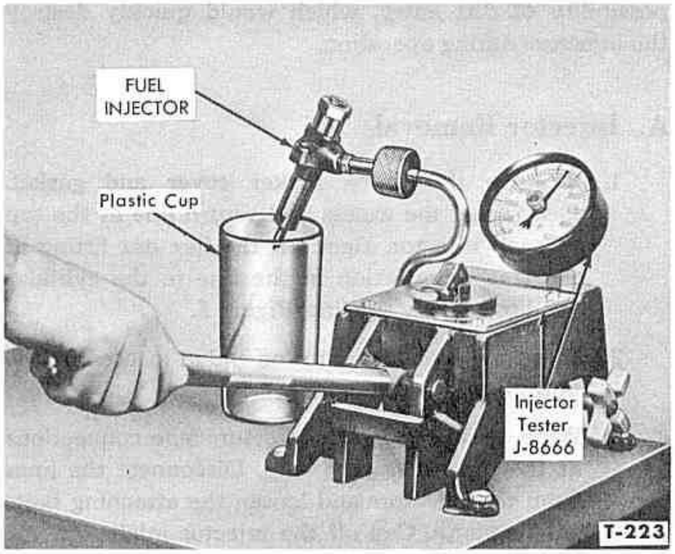


Figure 8—Checking Nozzle Opening Pressure

and guide the tapered edges into the stuck washer.

d. Tap the screwdriver handle sharply so that the blade bites into the washer then twist the screwdriver to free the washer.

B. Injector Tests

It is recommended that the injectors be tested before disassembly, as well as after being reassembled. Before testing, clean the outside of the injector with a good grade of carbon solvent and Brass Wire Brush J8537-27.

Check each injector as follows:

1. Connect the injector to the Injector Test Fixture J 8514. Pump the handle of the tester and observe the gauge reading at which the nozzle opens, Figure 8. The nozzle opening should be 2750 psi plus or minus 50 psi. To adjust the pressure, remove the injector cap nut and tighten or loosen the spring adjusting nut, Figure 7, as required.
2. Using a plastic cup, pump the handle of the tester and observe the spray pattern, as shown in Figure 8. All four sprays must be similar and spaced at approximately right angles to each other in a horizontal plane. Each spray should be well atomized and spread into about a two inch diameter cone six inches away from the injector.
3. Wipe the nozzle tip dry with clean blotting paper. Apply pressure to the injector, 150 psi below the nozzle opening pressure and hold the pressure for one minute. Apply a piece of blotting paper to the tip of the nozzle as shown in Figure 9. The fuel oil stain should not exceed ½ inch diameter.
4. Bring the injector pressure to above 2200 psi and measure the time it takes for the pressure to fall from 2200 psi to 1500 psi. The time should be between six and forty-five seconds. If the pressure drops through this range in less than six seconds, it indicates that there is dirt between the nozzle and injector body faces, Figure 10.

IMPORTANT: *If the injector passes the above tests, it is satisfactory to reinstall it in the engine. However, if the spray pattern is distorted, the fuel does not atomize properly, or if the injector fails the seat leakage test, the injector should be completely disassembled, cleaned, reassembled and tested once again.*

C. Disassembly

1. Secure the Holding Fixture J 8537-11 in a vise and place the injector in the fixture, Figure 11.

   NOTE: *Never clamp the injector body in a vise. This may cause distortion, excessive leaks or sticking of the needle.*

2. Remove the injector cap nut, then back off the spring adjusting nut. Lift off the upper spring disc, the injector spring and the spindle.
3. Remove the nozzle retaining nut with Nozzle Nut Wrench J8537-14, and remove the nozzle and valve, Figure 11.
4. Place all injector parts in clean fuel oil, or calibrating oil as they are disassembled.

   NOTE: *Nozzles and valves are a lapped fit, consequently they must never be interchanged.*

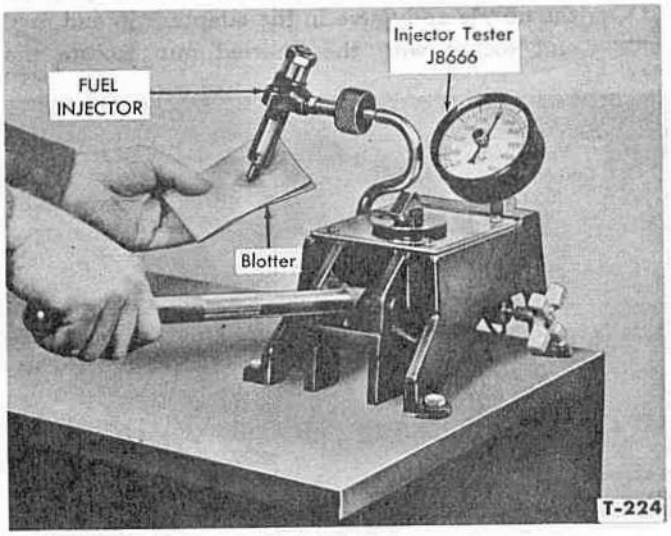


Figure 9—Checking Nozzle Seat Leakage

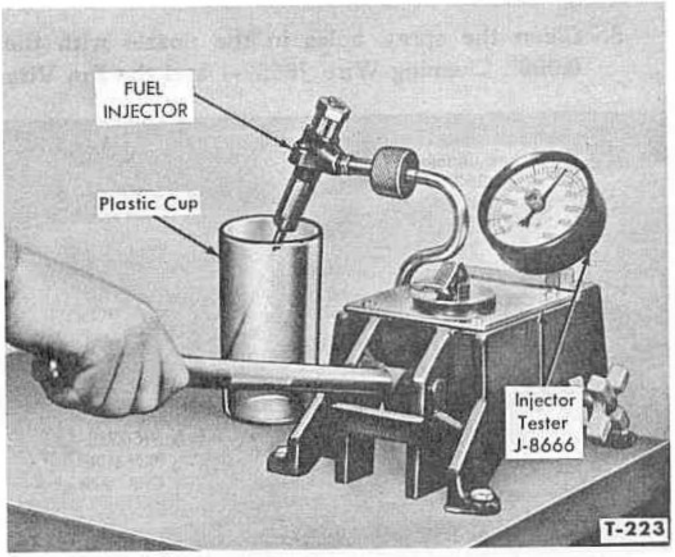


Figure 10—Checking Nozzle Leak Back

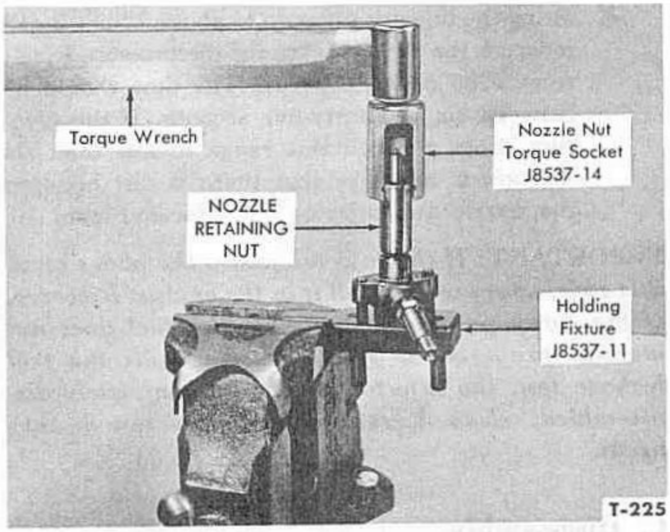


Figure 11—Removing Nozzle Retaining Nut

D. Cleaning

Use tools in Injector Nozzle Service Kit J8537 to remove all carbon from the nozzle and interior of the nozzle as outlined in the following steps:

1. Carbon deposits formed in the spray holes, and needle tip, should be softened by soaking the needle and nozzle in a carbon solvent for a short period. Then, use a soft wire brush to remove all carbon from the needle and nozzle exterior. It is important that the nozzle and needle be rinsed in clean fuel oil immediately after soaking in the carbon solvent to prevent corrosion on the highly finished surfaces.

2. Clean the pressure chamber of the nozzle with the 0.043″ Pressure Chamber Drill J8537-4, Figure 12.

3. Clean the spray holes in the nozzle with the 0.009″ Cleaning Wire J8537-1 and the Pin Vise J4298-1. The wire should protrude from the vise just enough to pass through the holes in the nozzle to prevent breaking the wire. Rotate the vise slowly without applying undue pressure to the cleaning wire, Figure 13.

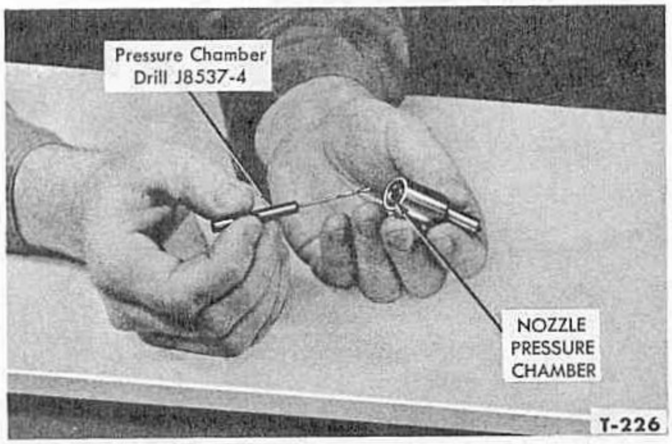


Figure 12—Cleaning Nozzle Pressure Chamber

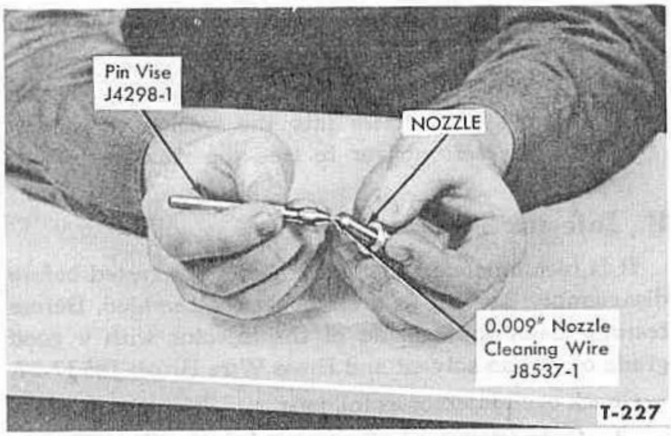


Figure 13—Cleaning Nozzle Discharge Holes

4. The seats are cleaned by rotating the Carbon Remover J8537-18 in the nozzle, Figure 14. Then, carefully clean the upper chamber with the same remover.

5. The annular groove in the top of the nozzle and the pressure chamber groove in the nozzle are cleaned with the Pressure Chamber Carbon Remover J8537-15, Figure 15.

6. Steps one through five have outlined the procedure for removing carbon from the nozzle. The nozzle and needle must be thoroughly back flushed to remove all the loosened carbon deposits. Place the Reverse Flush Nozzle Adapter J8537-6 on the injector tester. Then, position the nozzle and valve in the adapter, tip end first, and secure with the knurled nut. Rotate the

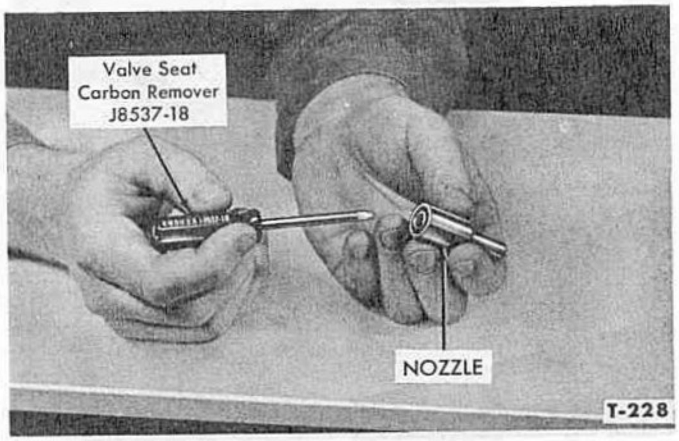


Figure 14—Cleaning Nozzle Seats

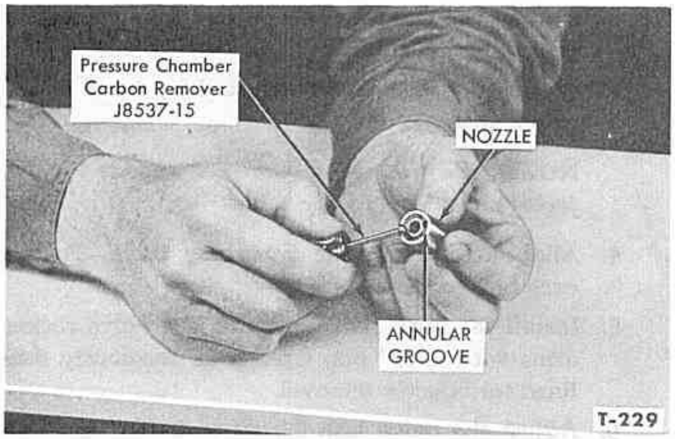


Figure 15—Cleaning Annular Groove in Nozzle

needle in the nozzle while flushing to make sure it is free.

7. After the nozzle is thoroughly back flushed to remove all loose carbon, the seat can be polished by placing a very small amount of tallow on the end of a Polishing Stick J8537-21 and rotating it in the nozzle, Figure 16.

8. If the back-leakage test was slower than forty-five seconds, or the valve sticks slightly, this can be corrected by remating the needle and the nozzle assembly, as shown in Figure 17. This is accomplished by using the special polishing compound consisting of tallow and a small amount of the finest lapping compound, Kent-Moore Part No. J8537-28, and then following one of the two methods given below.

   a. Hold needle in chuck and polish with a piece of felt, coated with a very small amount of the above compound.

   b. Place the nozzle in a drill chuck having a maximum rpm of 450. Apply a small quantity of the compound on the needle body, insert the needle in the body and turn it to lap. Hold the needle up off the pressure chamber shoulder while lapping to avoid damage to the needle. Care should be exercised so that the lapping compound does not damage the needle seat.

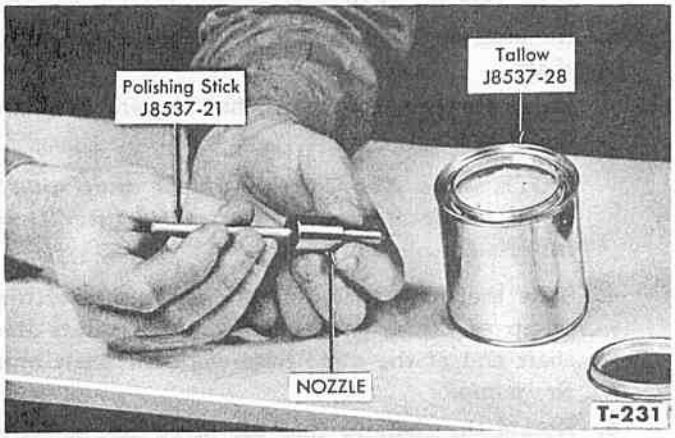


Figure 16—Polishing Nozzle Seats

9. The assembly must be thoroughly washed, back flushed with diesel fuel and cleaned after lapping.

E. Assembly

All injector parts should be reassembled wet after rinsing in clean fuel oil or calibrating oil.

1. Normally the injector inlet adapter need not be removed from the injector body. However, if the adapter is removed, it will be necessary to use a new copper washer to ensure a proper seal. Install and tighten the adapter in the injector body.

2. Position the nozzle and needle valve on the injector body, making certain that the dowel pins in the body are installed correctly in the nozzle. Position the nozzle retaining nut over the nozzle and tighten to 50 ft. lbs. torque with Nozzle Nut Wrench J8537-14. It will be necessary to place the injector in the Holding Fixture J8537-11 while torquing the nozzle nut, Figure 11.

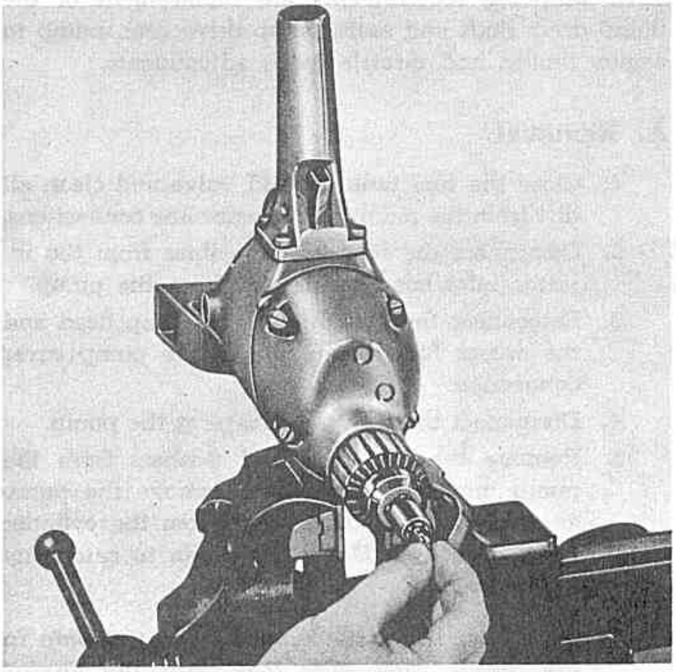


Figure 17—Lapping Needle in Nozzle

3. Position the spindle, spring, upper spring disc, and spring adjusting nut on the nozzle holder. Turn the adjusting nut in until pressure can be felt on the spring.
4. Connect the injector to the injector test fixture. Turn the adjusting nut in or out as required to obtain a nozzle opening pressure of 2750 psi.
5. Position a new copper gasket over the spring adjusting nut and install the injector cap nut. Repeat the nozzle opening pressure test to make certain it has not changed.
6. Test the injector as previously outlined on page 115. If, after cleaning, the injector fails to pass these tests, the needle and nozzle should be replaced.

F. Installation

1. Drop a new injector seat washer into each injector bore. Make certain that each washer lies flat in the bore.
2. Install each injector by positioning the nozzle end into its bore in the cylinder head and by guiding the injector rubber seal into its slot in the cylinder head.
3. Work each assembly downward by hand as far as possible.

   NOTE: ***Do not use a hammer to seat the injectors.***

4. Align and install the mounting bolts. Torque each bolt to 15 ft. lbs.
5. Install the push rods by lifting the valve rocker arms with a ½″ box wrench as previously outlined for injector removal.
6. Adjust the valve lash 0.014″ to 0.016″ for both exhaust and intake valves. Connect the injector excess fuel return line to the injectors and at the "tee" connection in the cylinder head.
7. Install the valve rocker cover and gasket, but do not connect the pressure lines to the injector inlets until after the injectors and lines have been flushed as outlined in Paragraph B, page 110.
8. After flushing and bleeding the injection system, reset the valve lash with the engine at normal operating temperature, 180°.

7. FUEL INJECTION PUMP

The fuel injection pump is mechanically driven by the engine camshaft and is self lubricated. Other than replacing the assembly as a complete unit, the only other servicing requirements are replacement of the pump drive shaft and seals, pump drive gear, pump to engine timing, and throttle speed adjustments.

A. Removal

1. Close the fuel tank shut-off valve and clean all dirt from the pump and injector line connections.
2. Disconnect the four pressure lines from the injector inlet connections and from the pump.
3. Disconnect the fuel line at the pump head and the excess fuel return line at the pump cover connection.
4. Disconnect the throttle linkage at the pump.
5. Remove the two nuts and washers from the pump mounting flange and remove the pump assembly and its drive shaft from the cylinder block as a unit. Use a drain pan to catch any fuel leakage.

   NOTE: ***If the drive shaft does not remain in the pump, fuel may leak into the engine crankcase during pump removal.***

B. Pump Drive Shaft Inspection

The injection pump drive shaft utilizes "U" cup seals, which may be replaced if defective. In addition, the shaft is serviced as an assembly for replacement purposes.

1. Carefully pull the shaft out of the pump housing with pliers and check the seals for cuts or tears.
2. Lubricate the new seals and "O" ring in diesel fuel to avoid damage and to facilitate ease of installation on the shaft. Carefully install the new seals onto the shaft with the sealing lips toward the ends of the shaft. Install the "O" ring on the shaft.
3. Lubricate the complete shaft assembly with diesel fuel.

   NOTE: ***The stepped end of the shaft must be at the lower end of the pump after it is installed.***

4. Slide the drive shaft into the shaft bore of the pump as far as the seals. Carefully rotate the shaft and at the same time work the shaft into the pump.
5. Rotate the shaft so that the drive tang is fully seated in the distributor rotor. When the shaft is

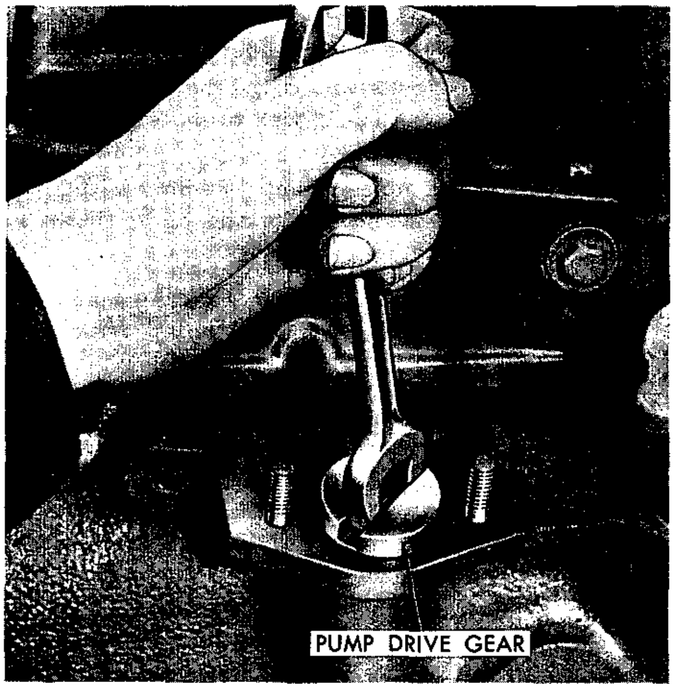


Figure 18—Removing Pump Drive Gear

correctly positioned, the drive tang shoulder at the opposite end of the shaft will be approximately 1/16" below the top of the shaft bore in the pump.

C. Pump Drive Gear Servicing

The pump gear, shown in Figure 18, is driven by an integral gear on the camshaft and, in turn, drives the injection pump drive shaft and the engine oil pump. Normally, this drive gear is removed only if it is to be replaced or when engine overhaul requires its removal.

Pump Drive Gear Removal:

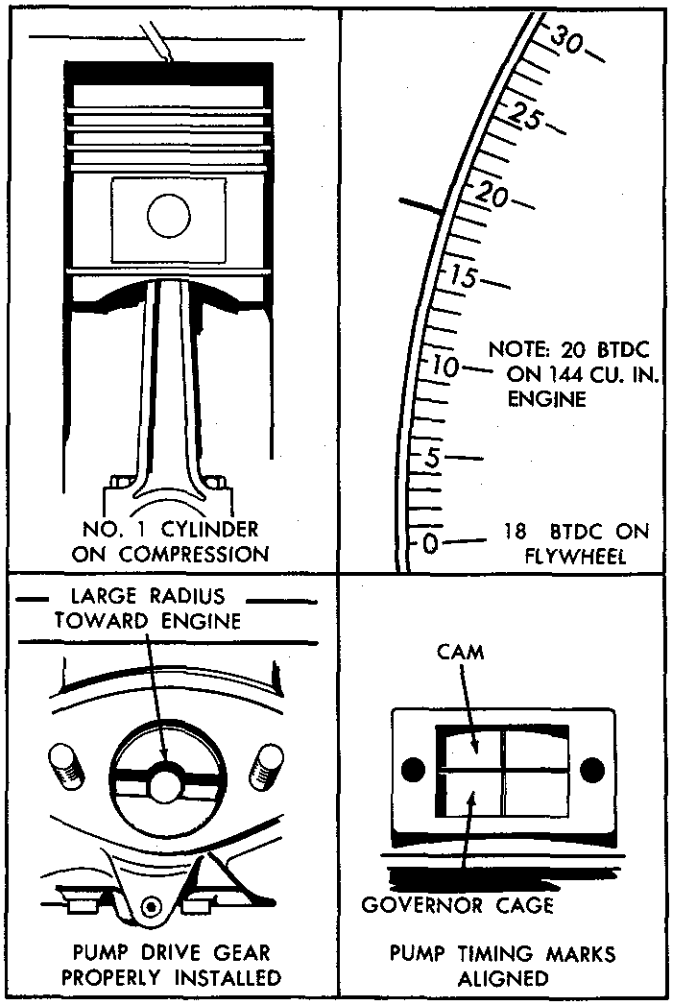
Position a wrench or wide blade screwdriver in the slot of the drive gear and turn it clockwise to remove the drive gear from the engine as shown in Figure 18.

Pump Drive Gear Installation:

The fuel injection pump must be timed with the valves, therefore, it is extremely important that the pump drive be installed correctly to insure proper timing of the pump.

1. With the engine rocker cover removed, crank the engine over until No. 1 cylinder is on compression.
2. *Check the flywheel timing and adjust for* 18° BTDC on 172 cu. in. engines or 20° on 144 cu. in. engines.
3. Initially position the pump drive gear in the bore of the cylinder block so that the slot is approximately vertical and proceed as follows:
   - (a) Rotate the gear counterclockwise about 1/4 turn to install.
   - (b) When properly meshed, the slot in the top of the gear will be approximately horizontal as shown in Figure 19.

     IMPORTANT: ***The slot in the top of the gear is off center in relation to the counterbore. When the gear is properly installed, the larger radius of the counterbore will face toward the tractor as shown in Figure 19. If the gear is installed in the reverse (with the large radius facing away from the tractor) the injection pump, when installed, will be 180° out of phase.***
   - (c) If the pump drive gear shaft does not enter the oil pump shaft, press down on the gear and crank the engine until it drops into place.


NO. 1 CYLINDER ON COMPRESSION
30
25
20
15
10
5
0
NOTE: 20 BTDC ON 144 CU. IN. ENGINE
18 BTDC ON FLYWHEEL
LARGE RADIUS TOWARD ENGINE
PUMP DRIVE GEAR PROPERLY INSTALLED
CAM
GOVERNOR CAGE
PUMP TIMING MARKS ALIGNED

ALL FOUR STEPS MUST BE TAKEN FOR CORRECT PUMP TO ENGINE TIMING T-266

Figure 19—Injection Pump to Engine Timing Sequence

D. Fuel Injection Pump Installation and Timing

Prior to installing the pump, the engine flywheel timing mark must be at 18° BTDC (172 cu. in. engine) or 20° BTDC (144 cu. in. engine) with No. 1 cylinder on compression.

1. Install a new "O" ring on the pilot diameter of the pump mounting flange.
2. Blow any dirt out of the pressure lines with an air hose.
3. Install new washers—one on the inside and one on the outside of each banjo fitting and bolt the pressure lines loosely to the pump head.
4. Turn the pump drive shaft counterclockwise several times to make sure there is no binding in the pump.
5. Remove the timing window cover and gasket, then turn the shaft counterclockwise until the movable timing mark on the governor cage is about 1/8" to the right of the fixed mark on the cam.
6. Install the pump on the engine, making sure that the tang on the pump shaft seats in the slot of the pump drive gear.
7. Remove any backlash in the pump and drive gear as follows:
   a. Rotate the engine with the starter until the timing mark in the pump is out of sight at the right side of the window.
   b. Use a screwdriver on the flywheel ring gear to bring the mark back to its original alignment position.
8. Rotate the complete pump assembly slightly so that the timing marks are aligned as shown in Figure 19.

IMPORTANT: ***If the timing marks cannot be aligned, recheck for proper pump drive gear installation.***

9. Secure the pump assembly in position after the timing marks have been properly aligned and rotate the engine two complete revolutions. The timing marks should again be in alignment. The flywheel should read 18° BTDC (172 cu. in. engine) or 20° BTDC (144 cu. in. engine) and No. 1 cylinder should be on compression. If these factors disagree, recheck the previous steps.
10. Install the timing window cover on the pump using a new gasket.
11. Connect the throttle linkage to the pump, plus the excess fuel line to the pump cover and the fuel line to the pump head. Do not connect the pump pressure lines to the injector inlets until they have been flushed as outlined in Section 3, page 110.

8. MANIFOLD, MUFFLER AND OUTLET PIPE

The intake and exhaust manifolds are separate units on the Ford Diesel Tractor. However, a single manifold gasket is utilized for both manifolds. The muffler is mounted directly above the manifolds as shown in Figure 20.

The air cleaner is mounted directly to the intake manifold. Air is drawn in from a pre-cleaner and a grille located on the left rear side of the hood through an air inlet tube to the intake manifold.

A. Manifold Removal

1. Remove the clamp that secures the outlet pipe to the muffler outlet pipe support elbow. Lift the outlet pipe, clamp and rain cap off the elbow as an assembly. Remove the rain cap from the outlet pipe if either is to be replaced.
2. Remove the four bolts that attach the heat shield to the fuel tank supports and remove the heat shield, Figure 20.
3. Disconnect the wire from the manifold rear heater. Loosen the clamp that secures the air intake tube to the air cleaner. Remove the two air cleaner attaching bolts and remove the air cleaner.

NOTE: ***Do not disconnect the manifold heater wire if the intake manifold is not going to be removed.***

4. Remove the nut and bolt that attaches the upper part of the muffler outlet pipe support elbow to the fuel tank front support. Remove the bolt that attaches the elbow to the cylinder head. Remove the elbow from the muffler.
5. Loosen the one nut that attaches the exhaust manifold to the cylinder head one turn. Hold the nut in that position then run another nut against it to act as a jam nut as shown in Figure 21. Remove the stud from the cylinder head.
6. Remove the four attaching bolts and washers. Lift the exhaust manifold up and away from the cylinder head.

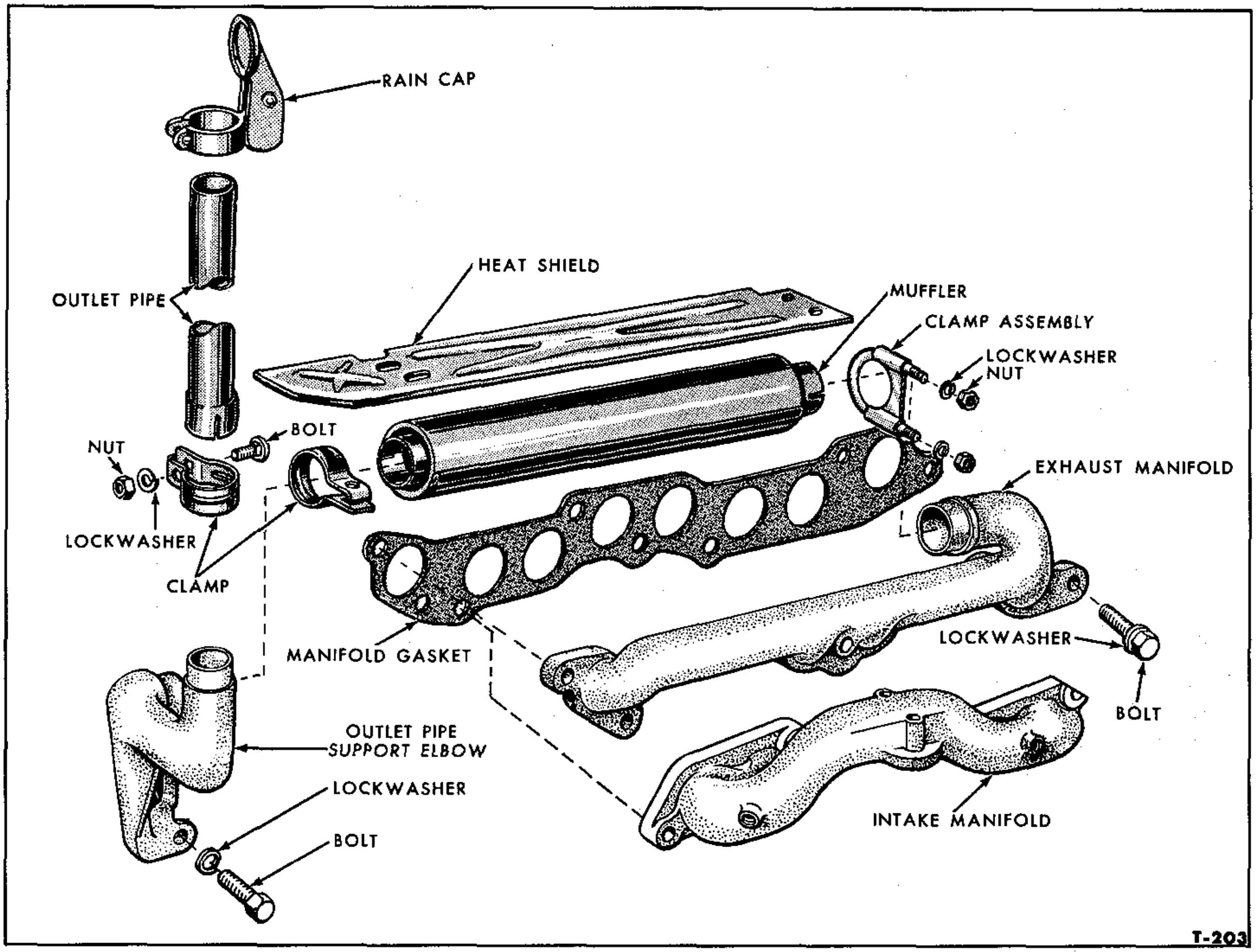


Figure 20—Manifold and Muffler Disassembled

7. Remove the one bolt, two nuts and three flat washers that attach the intake manifold to the cylinder head. Lift the manifold from the head.
8. Clean all gasket material from the manifolds and cylinder head.
9. Remove the clamp that secures the muffler to the exhaust manifold. Separate the muffler from the manifold.

B. Manifold Inspection

1. If the manifolds have been in use for some time, deposits of gum may be present in the intake manifold as well as carbon in the exhaust manifold. These deposits may cause poor engine performance. It is good practice to clean the manifolds thoroughly, every time they are removed from the engine. Soak the manifolds in a good solvent to loosen gum and carbon deposits, then dry them thoroughly.
2. Be sure the air cleaner mounting gasket is removed.
3. Examine the manifold for cracks or defects such as warpage, or chips out of the mounting surface. Always replace a warped or cracked manifold.

C. Manifold Installation

1. Place a new gasket on the manifold studs. Position the intake manifold on the studs and secure with three flat washers, one bolt and two nuts. Tighten the nuts and bolts to 40-50 ft. lbs. torque.
2. Position the clamp on the inlet end of the muffler. Install the muffler on the exhaust manifold and work it back as far as possible. Position the clamp so that the nuts are facing away from the manifold mounting surface, then tighten them.
3. Hold the exhaust manifold and muffler in place

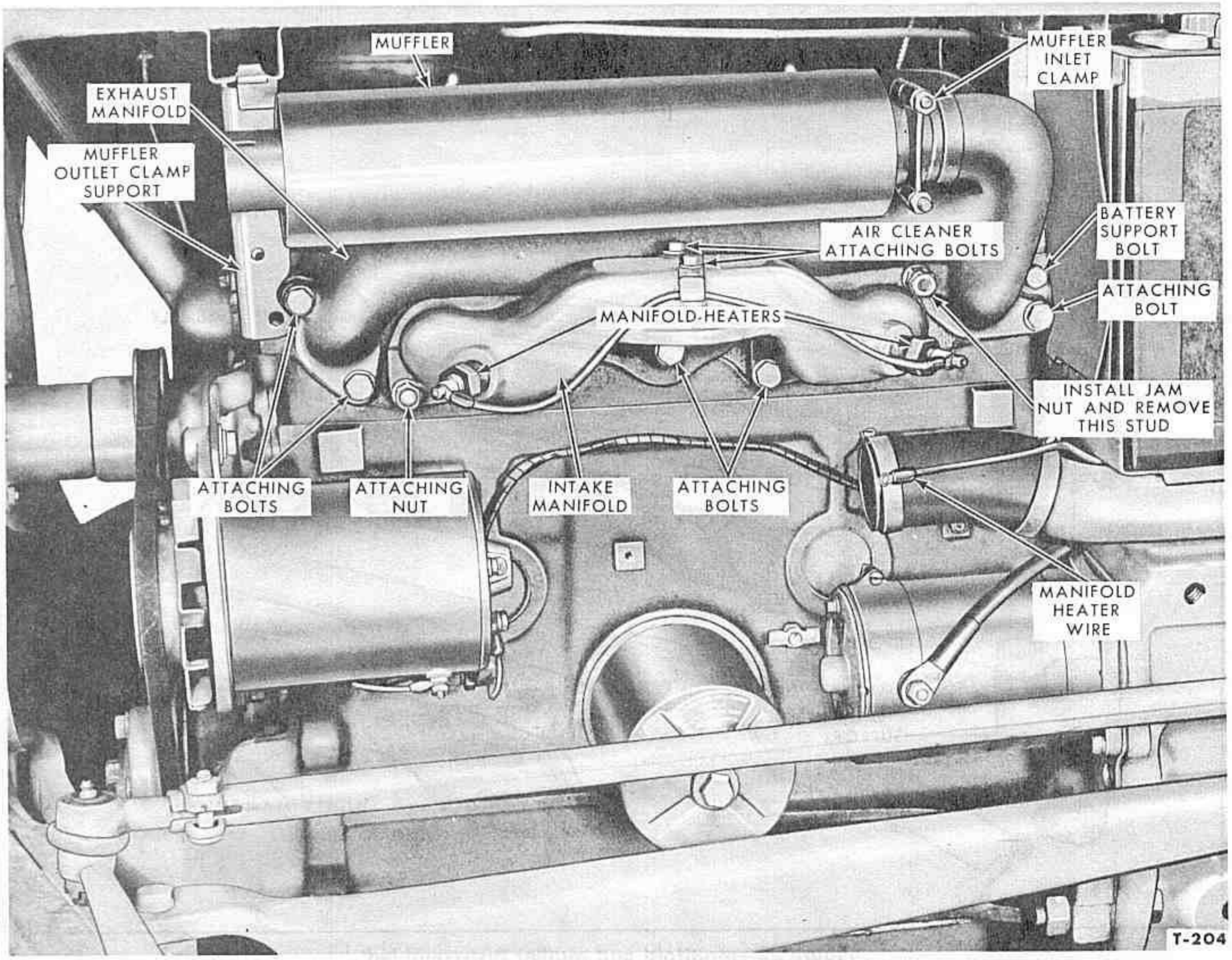


Figure 21—Intake and Exhaust Manifold Installed

on the cylinder head and install the four bolts, one stud, flat washers and nuts. Tighten the attaching bolts and nuts evenly and alternately to 40-50 ft. lbs. torque.

4. Place a clamp on the outlet end of the muffler. Install the muffler outlet support elbow in the muffler with the two mounting bolts in alignment with the hole in the fuel tank support bracket and cylinder head. Install the two elbow attaching bolts, tighten the muffler front clamp.
5. Secure the heat shield to the fuel tank supports with the four attaching bolts.

   NOTE: ***The nut, bolt and lockwasher is used in the upper hole.***
6. Position the outlet pipe, rain cap assembly and clamp on the outlet support elbow. Tighten the clamp to secure the outlet pipe.
7. Connect the wire to the manifold rear heater.
8. Install a new gasket on the intake manifold, then install the air cleaner.

9. TROUBLE SHOOTING

The trouble shooting procedures contained in this section pertain only to the diesel fuel system and component parts. The diesel fuel system consists of the air cleaner, the fuel tank, fuel filter, fuel injection pump, fuel injectors and the connecting fuel lines.

It cannot be stressed too strongly for keeping the diesel fuel system free of dirt. Most all of the troubles in the system can be contributed to dirt.

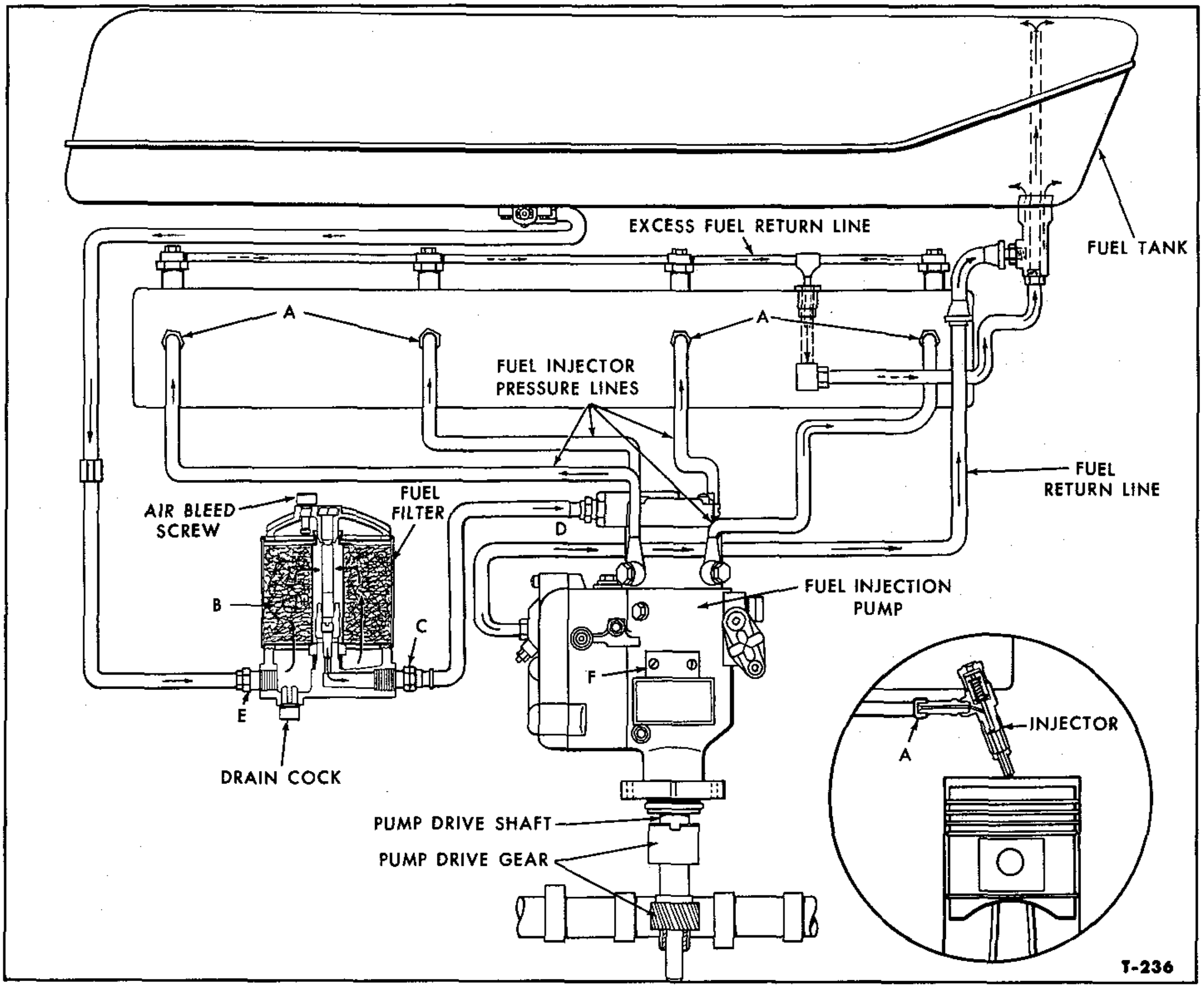


Figure 22—Diesel Fuel System

A. Engine Will Not Start

1. Check the fuel tank to make sure that there is fuel in the tank, that the fuel shut-off valve is in the "ON" position, and that the hand throttle is open.
2. Disconnect the air cleaner tube from the air cleaner. If the engine will start with the air cleaner disconnected, clean the air cleaner as detailed on page 109.
3. Disconnect the fuel line at (D), Figure 22. If fuel does not flow freely from the line, check for a clogged fuel filter or an obstructed line between this point and the tank. Make the necessary repairs, and bleed the fuel system.
4. If the engine still won't start, remove the timing inspection window cover (F) from the fuel injection pump. Crank the engine with the starter and observe the injection pump rotor. If the rotor does not turn, the pump drive shaft may be broken, or the pump drive gear and/or engine camshaft gears can be stripped, Figure 22. Make the necessary repairs and time the engine.
5. If the engine still will not start, loosen the nut (A) at each injector. Crank the engine with the starter to make sure that fuel is reaching the injectors. If fuel is reaching the injectors, remove them from the cylinder head and rebuild or replace them as required.
6. If the engine still won't start, refer to the **ENGINE TROUBLE SHOOTING SECTION** page 46 of this manual.

B. Engine Starts Then Stops

1. Check the air cleaner to make certain that the oil is to the proper level and that the filter is not obstructed.
2. Check the fuel filter and replace as required.

C. Excessive Black Smoke From Exhaust

1. Check the fuel injection pump timing and time the pump as detailed on page 120.
2. Check the nozzle opening pressure of the fuel injectors. The nozzle opening pressure should be 2750 psi plus or minus 50 psi. If the pressure is not within limits, adjust the nozzle opening pressure.

D. Engine Lacks Power

1. Check for presence of air in the fuel system by opening the bleed screw at the top of the filter to bleed the lines and filter.
2. If bleeding the system does not correct the trouble disconnect the fuel line and check the flow of fuel at (D), see Figure 22. If the fuel does not flow freely, clean the obstruction from the lines or replace the fuel filter (B) as required.
3. Check the air cleaner to make sure it is not obstructed.
4. Check the injection pump timing and time the pump as detailed on page 120.
5. Check the fuel injectors to make sure they are operating properly. Repair or replace the injectors as required.
6. If the preceding steps do not correct the trouble, refer to the ENGINE TROUBLE SHOOTING SECTION on page 46 of this manual.

E. Engine Misfires or Misses

1. Disconnect fuel line fitting (D), Figure 22, to make certain that an adequate supply of fuel is reaching the injection pump. If the fuel supply is insufficient, replace the fuel filter, bleed the lines or remove any obstructions that may be present.
2. Start the engine and allow it to run at 600 rpm. Loosen one injector pressure line nut at a time. Observe the engine rpm each time an injector pressure line nut is loosened. The engine rpm should drop. If not, remove that particular injector and make the necessary repairs or adjustment.
3. If none of the injectors are at fault, refer to the ENGINE TROUBLE SHOOTING SECTION page 46 of this manual.

F. Hard Starting

1. Check the air cleaner for restrictions.
2. Check the fuel lines and filter for restrictions.
3. Bleed the fuel system.
4. Check the fuel injection pump timing as detailed on page 120 and make the necessary corrections.
5. In cold weather, refer to the Owner's Manual for operating the tractor in weather below 15° F.
6. After making the above corrections if the trouble still prevails, refer to the ENGINE TROUBLE SHOOTING SECTION page 46 of this manual.

10. SPECIFICATIONS

Fuel

Diesel Type	Cetane Rating (Minimum)	Temperature Range for Recommended Use
No. II	45	Above 20° F.
No. I	50	Below 20° F.

Fuel Injection Pump

Type	Distributor Type

Fuel Injectors

Type	Simms NL-141, 4 Orifices 0.27 MM Diameter, 150° Spray Angle
Number Injectors	4

Fuel Tank

Capacity Full	17 Gallons
Reserve	No

11. SPECIAL TOOLS

To perform inspections and repairs on diesel fuel injectors, it is essential that the following equipment and tools are available:

Tool No.	Description
J 8666	Injector Tester
J 8537	Injector Nozzle Service Kit
DDN-17098	Injector Pulling Tool

Part ONE

POWER PLANT

Chapter

VI

Fuel and Exhaust System — LP-Gas

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The term LP-Gas is an abbreviation for liquified petroleum gas which is principally propane, butane or a mixture of both. In their natural state, these compounds are vaporous fuels and when separated from a variety of similar compounds, they can be condensed into a liquid state by compression and cooling. To maintain these fuels in a liquid state at average temperatures, they must be kept under pressure. Temperature variations of the confined liquid induces pressure changes from a few pounds in cold weather to higher pressure in hot weather. These liquids boil or vaporize at low temperatures. Butane boils at +31° F. and propane boils at —44° F. Mixtures of these two liquids have boiling points between these two values.

In considering LP-Gas for engine fuel, it should be remembered that propane or butane, as confined liquid under pressure, is constantly striving to return to a gaseous state. By opening a valve on a tank, the liquid escapes in force in much the same manner as does steam when it is released. The liquid turns into vapor, but, being heavier than air will settle to the ground and eventually will disappear into the atmosphere. With the proper controlling components for LP-Gas engine carburetion, this vaporization makes LP-Gas an ideal fuel. However, due to the tremendous amount of heat absorbed by this liquid fuel, as it vaporizes, it tends to ice or freeze up the components which confine it. Propane and butane are clean burning and leave virtually no combustion deposits and no contamination of the lubrication system. Due to the purity of these fuels, engine maintenance per hours of operation is reduced. LP-Gas is highly volatile and because of its volatility, it requires different methods of handling and storage. If handled properly, LP-Gas is as safe as any other fuel.

The Ford LP-Gas system is used with 134 and 172 cubic inch displacement Ford Tractor engines.

1. CONSTRUCTION

The LP-Gas fuel system used on the Ford Tractor consists of a heavy gauge fuel tank with valving; a fuel filter; a vaporizer and regulator; a carburetor and the connecting fuel lines, Figure 1. The construction and operation of the LP-Gas system is explained under headings which indicate the component involved.

On later model LP-Gas Tractors, the regulator is an integral part of the carburetor, whereas, on early models, the regulator is attached directly to the vaporizer.

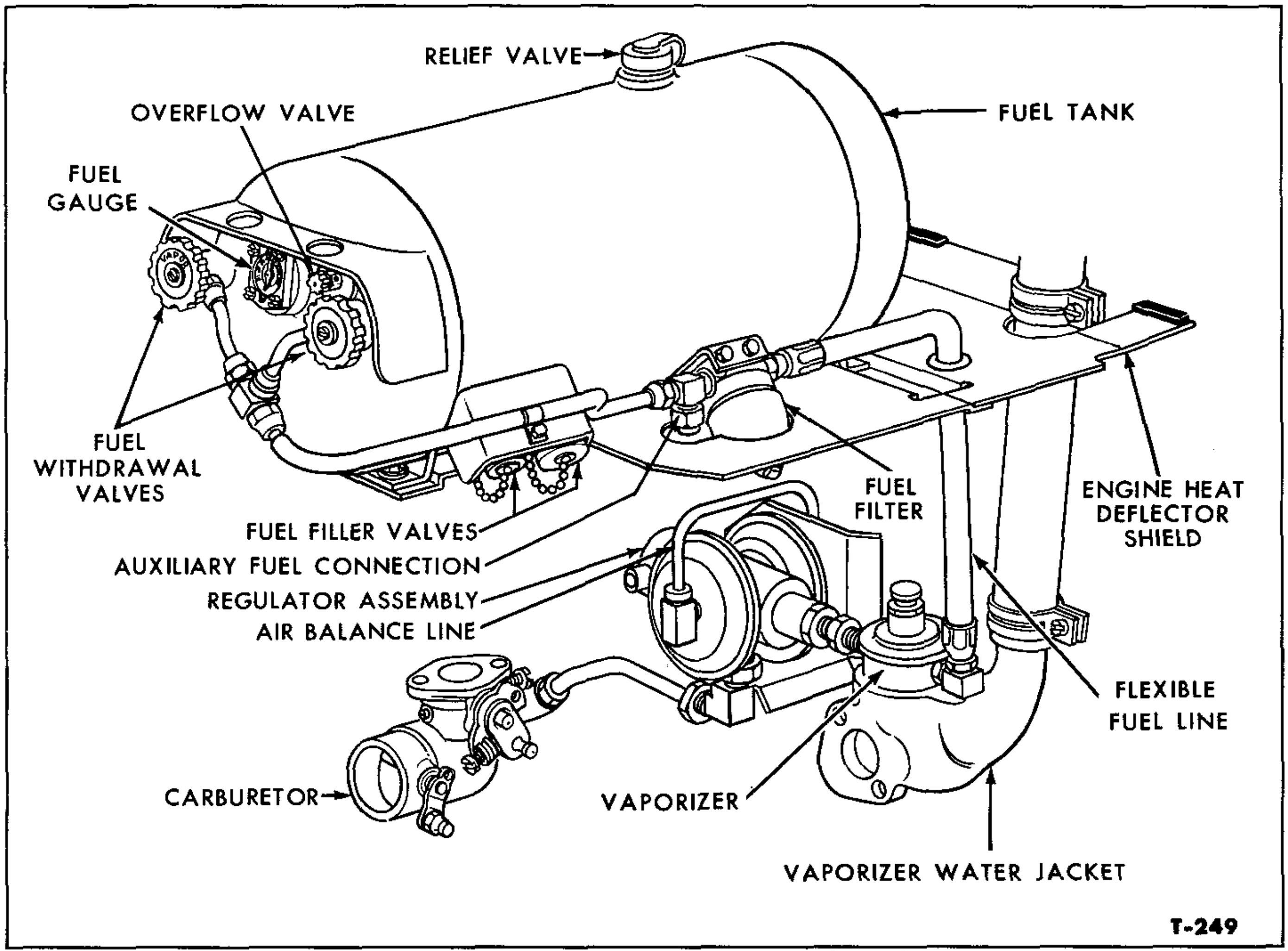

Figure 1—LP-Gas System Components—Early Model

A. Fuel Tank and Valving

The fuel tank is a three section welded unit with a capacity of 24 U.S. gallons. The liquid volume recommended, however, is 19.2 gallons or 80% of its total capacity. Since LP-Fuels remain in a liquid state only under pressure, the remaining 20% of the tank capacity is required for vaporized fuel and liquid expansion. The tank is mounted directly over the tractor engine and is bolted to the tank supports. A heat deflector shield is used between the tank and engine to reduce fuel expansion due to heat from the engine.

Relief Valve: A relief valve located at the top forward end of the tank is pre-set to operate at 312 psi. It functions to prevent the tank against excessive pressures by venting the fuel to the atmosphere.

Fuel Withdrawal Valves: Mounted on the rear of the tank, the liquid withdrawal valve at the right, and the vapor withdrawal valve to the left, provide the manual control of liquid or vaporized fuel flow from the tank for carburetion purposes. The liquid withdrawal valve is internally piped to the lower portion of the tank to supply liquid fuel for engine operation and the vapor withdrawal valve draws vaporized gas from the upper portion of the tank for initial engine starting. Each of these valves contain an integral "excess flow valve" which closes off the fuel supply automatically under emergency conditions that may arise due to damage of the tubing, fuel filter, vaporizer or regulator.

Fuel Gauge: The fuel gauge is located between the two withdrawal valves and it is calibrated from 0 to 95 percent to indicate liquid fuel volume within the tank.

NOTE: ***This gauge does not measure tank pressure.***

The gauge is equipped with a float mechanism which activates an indicator needle magnetically to show the correct liquid volume percentages. The gauge assembly is secured to the tank with screws.

Fuel Filler Valves: Two fuel filler valves are located on the right side at the lower rear end of the fuel tank. These valves are used for fuel transfer from a storage tank.

The liquid filler valve (largest valve) provides a fuel line connection for transfer of fuel from the storage tank to the tractor fuel tank. The vapor return valve provides a means for vapor return to the storage tank for purposes of equalizing the pressure in both tanks during fuel transfer. Both valves are equipped with covers to prevent dirt entry into the valve components.

Fuel Overflow Valve: This valve is located at the rear of the tank between the withdrawal valves. The fuel overflow valve is used as an additional means of determining the 80% fill level. The valve is operated manually by alternately opening and closing the vent until liquid fuel appears.

B. Fuel Filter and Auxiliary Fuel Connection

The fuel filter assembly is bolted to the filter support on the lower center section of the tank at the right side of the tractor. It is heavily constructed to withstand tank pressures and contains a replaceable metal filter element which functions to remove foreign particles in the fuel passing from the tank to the pressure reduction components.

An auxiliary fuel connection is a "tee" connector located just to the rear of the filter assembly in the fuel tank line. The connector is used for attaching portable LP-Fuel bottles for tractor operation when it is not convenient to fill the tractor fuel tank.

C. Vaporizer

This unit is bolted to the cooling system liquid outlet of the engine. It is connected at its fuel inlet side to the filter fuel line and to the regulator at its outlet connection (early models only). The vaporizer consists of a pressure reduction unit with integral valving and is housed in a water jacket. This assembly functions to vaporize fuel fed from the tank and to reduce the pressure of the expanding vapor to 10 psi (gauge pressure) which represents the first stage toward preparing the fuel for carburetion. A water jacket or outlet housing is employed to circulate warm water from the engine cooling system around the confined vaporized fuel to assist in a more rapid vaporization of the fuel.

D. Regulator

The regulator is attached to the fuel outlet connection of the vaporizer assembly and to the fuel intake side of the carburetor by means of a fuel line (early models only). It consists of a pressure reduction unit with internal valving and two diaphragm assemblies which are vented by a line to the atmosphere.

A deflector shield is secured at the inlet connection of the assembly and serves to direct the air blast from the radiator fan to the under side of the heat shield to cool the shield. The regulator receives vaporized fuel from the vaporizer and further reduces the pressure of the expanding gas from 10 psi gauge pressure to slightly below atmospheric pressure.

On later models, the regulator is an integral part of the carburetor. However, the function is the same as the regulators attached to the vaporizer on earlier models.

E. Carburetor

The LP-Gas carburetor is bolted to the carburetor mounting flange of the intake manifold. Basically, this carburetor performs the same function as the Ford gasoline carburetor with the exception that it receives fuel in a vaporized state rather than in a liquid form which eliminates the need for a float. The same adjustments and throttle linkage are employed on the LP-Gas carburetor as are used for the Ford gasoline carburetor. The fuel line leading from the regulator, (early models only), supplies vaporized gas in the amount required by the carburetor. On late models, the regulator is an integral part of the carburetor. Its function remains the same. The carburetor proportions gas and air to produce the proper mixture for engine operation. The balance line is a means of subjecting the regulator diaphragms to the proper pressure for controlling gas flow through the fuel line. A very slight volume of air passes through the balance line, in one direction or the other, as the engine load increases or decreases.

NOTE: ***The same carburetor is used on both the 134 cu. in. and 172 cu. in. engines.***

2. PRINCIPLES OF OPERATION

The operating principles of the Ford LP-Gas carburetion system are essentially the same as those governing gasoline engines. LP-Gas under pressure, however, must be reduced to working pressure which is compatible with engine carburetion and fed to the engine in proportions required at any given rpm.

Normally, a cold engine is started on vapor withdrawal from the tank. A quantity of vapor in the tank is sufficient to run the engine (under no load) through the warm-up period. However, the vapor supply within the tank is usually insufficient for continued operation; therefore, when the engine reaches operating temperature, liquid fuel should be fed into the system for a rapid vaporization in the water heated vaporizer assembly. Figure 2 illustrates, in schematic form, the flow processes by which the fuel is prepared for engine use.

This process is explained in the following:

A. Early Models

With the liquid withdrawal valve open, liquid fuel under pressure flows to the filter assembly from the tank. Passing through the sides of the filter element it flows through the filter outlet to the inlet valve of the vaporizer (A). Spring pressure unseats the inlet valve (B), and the fuel flows into the vaporizing chamber (C), where it expands into vaporized gas. Spring action on the inlet valve combined with gas pressure acting on the diaphragm at (D), opens and closes the inlet valve (B), until a constant regulated pressure of 10 lbs. (gauge) is obtained in chamber (C).

With the engine turning over under its own power, or from power supplied by the electric starter, a vacuum condition (slightly less than atmospheric pressure) is set up in the chamber (E) of the regulator. The air balance line (H), applies atmospheric pressure, for all practical considerations, to the outside of the regulator diaphragms (G). This difference in pressure on the outside of the diaphragms causes the two regulator diaphragm assemblies to draw inward against the leaf spring portion of the valve block assembly (F), lifting the valve block from its seat in the inlet orifice. Vaporized fuel then passes from the vaporizer outlet and into the chamber (E). The pressure in chamber (E), rises to atmospheric pressure and the valve block assembly (F), closes under the force of the coil spring (I).

The system of passages in the carburetor (J) sets up a condition of vacuum in the tube (K) and chamber (E), that results in the proper flow of fuel and air to the engine intake manifold to suit the power demands from the engine.

The choke valve at the carburetor inlet must be temporarily closed to obtain a richer mixture for starting purposes.

B. Late Models

The fuel pressure at the fuel inlet (15), Figure 3, is controlled by the primary regulator in the fuel system and is set at 10 psi. The diaphragm chamber (7), receives ventilation through the orifice (11), and channel (13), from the air intake (10). The diaphragm chamber (4), communicates directly to two pressure areas in the throttle body of the carburetor. Through channel (2) orifice (6) and annulus (9), fuel reaches the throat of the venturi (8). Through channel (2), and the idle fuel orifice (1), it connects into the area beyond the throttle plate (B). The pressure transmitted to the diaphragm chamber (4), will vary with the position of the throttle plate. Thus, whichever of the two areas (above the throttle plate or at the throat of the venturi) produces the lower pressure will be most influential in the movement of the diaphragms (H) and (F). The position of these diaphragms controls the pressure in the fuel chamber (5).

If the idle fuel adjustment needle (A), were seated, the pressure across diaphragm (H) would be the same as the pressure difference between the air intake and the throat of the venturi. At idle speed, this pressure difference would be insufficient to cause the diaphragms to open the fuel inlet valve against the force of its spring. However, by opening the idle fuel adjustment needle (A), Figure 3, the low pressure prevailing above the nearly closed throttle plate can communicate through channel (2) to the diaphragm chamber (4) and create the necessary pressure difference across the diaphragm (H), to establish fuel flow. The size of the main jet (E), regulates the maximum flow of fuel.

To obtain good fuel economy at part throttle operation without sacrificing full power when required and without affecting a good idling mixture, a back-suction type economizer is provided. Reduced fuel flow is accomplished in the part throttle range by allowing the low pressure beyond the throttle plate to communicate through the back-suction orifice (3), into channel (16). The relationship of the orifice area to the ventilating channel area determines the extent of pressure change. The relationship of the location of the orifice to the position of the throttle plate determines the operating range in which the fuel flow is reduced.

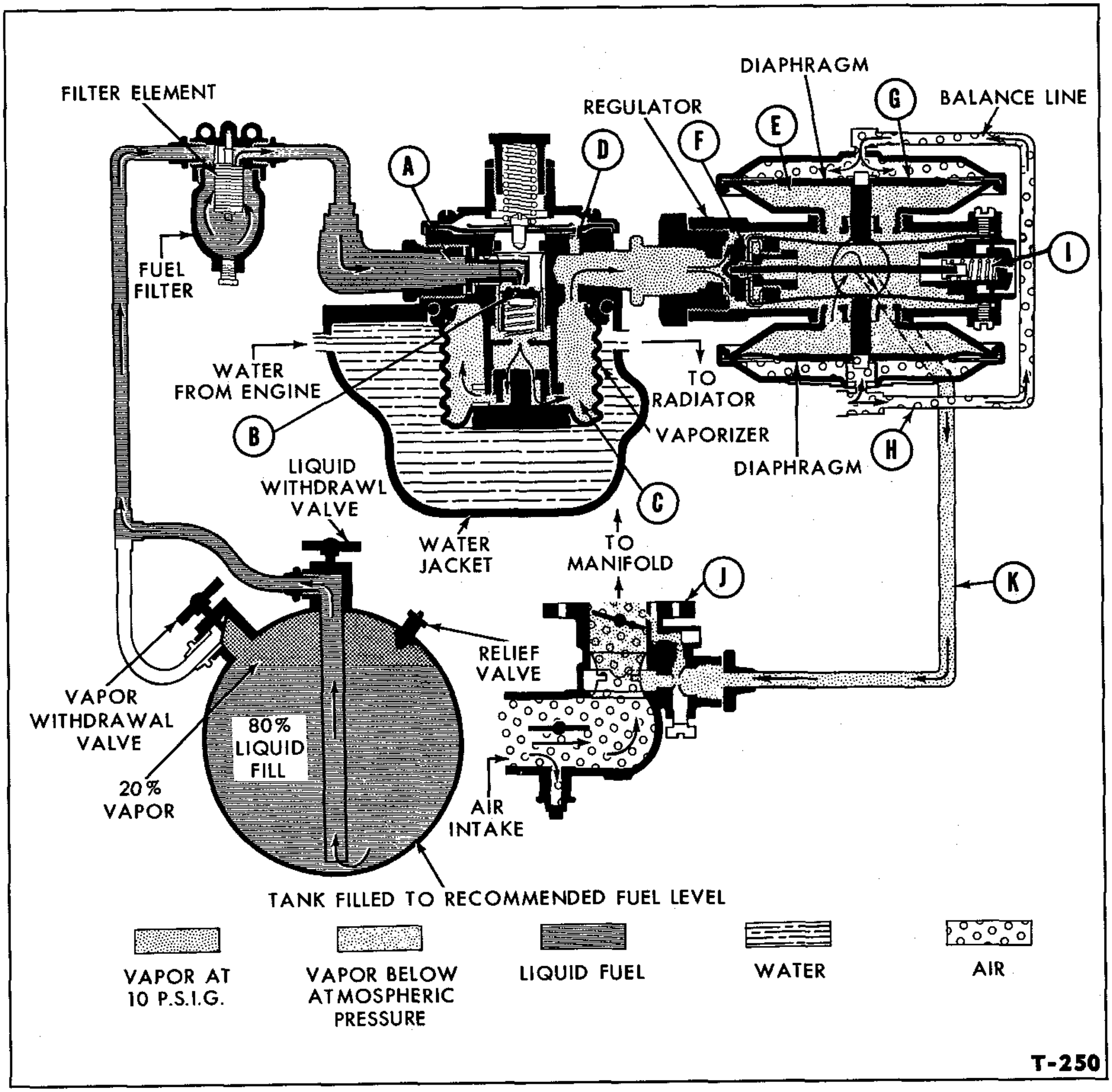

Figure 2—Schematic View, Ford LP-Gas System—Early Models

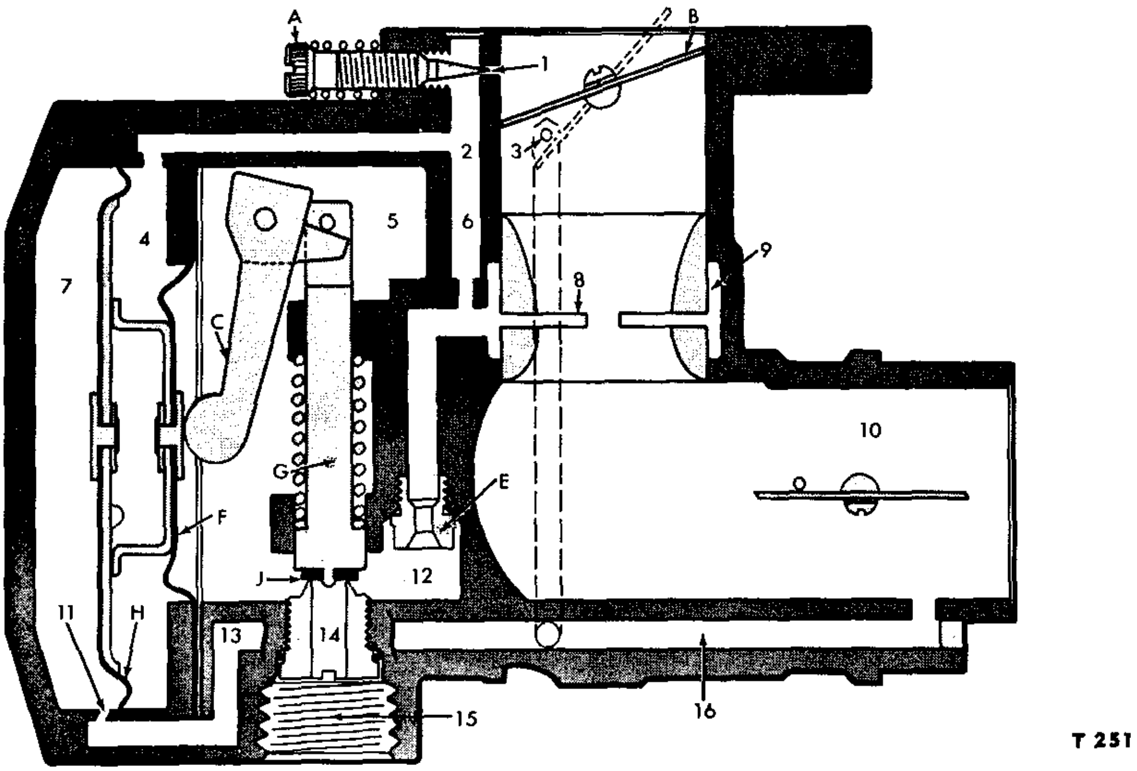

Figure 3—LP-Gas Carburetor—Sectional View—Late Model

3. HANDLING OF LP-GAS

The Ford LP-Gas tractors have been approved by the Underwriters Laboratories and conform to requirements of the National Board of Fire Underwriters: however, there are many states and localities which have laws and regulations in addition to the Underwriter requirements. There may be additional state and local requirements which Distributors and Dealers must comply with in order to sell, service and warehouse these tractors. Therefore, it will be necessary that each Distributor and Dealer contact their local and state authorities to determine what these requirements are.

The Underwriter regulations are covered in Pamphlet No. 58, obtainable from the National Board of Fire Underwriters at the following addresses:

85 John Street, New York 38, New York

222 West Adams Street, Chicago 6, Illinois

465 California Street, San Francisco 4, California

A. Tractor Shipment

Tractors will be shipped from the factory with sufficient fuel in the tank for starting and moving them during shipment.

B. Fire Protection

The precautions to be used in handling LP-Gas are similar to those required for any other commercial gases.

It should be remembered, however, that the gas even when premixed with air, is heavier than air. Likewise, it should be remembered that its flammable limit is lower than for other commercial gases. It is possible, therefore, for the gas to hang closer to the floor and form a flammable mixture sooner than in the case of most other fuel gases.

If a gas leak develops, every effort should be made to first remove all sources of ignition within a reasonable distance. Increased dissipation of the gas into the air can be induced by increasing the air circulation.

If gas from a leak is ignited, the first major decision is to determine whether the fire should be extinguished or merely controlled. If it appears possible to stop the gas leakage such as by closing a valve, it may be desirable to extinguish the fire in the minimum length of time. On the other hand, if it appears uncertain or doubtful that the source of leakage can be stopped, it may be desirable to control the fire without attempting to extinguish it until the gas has been completely consumed.

If a fire occurs near an LP-Gas storage container, the prime consideration should be to make sure all withdrawal valves are closed so as to prevent any gas from escaping which might become ignited. If the fire is of sufficient magnitude so as to heat the metal of the tank in the vapor space appreciably, it is desirable to cool the top of the tank with water.

C. Fire Fighting Methods

Since the relief valves on a storage container will close when the pressure in the tank is reduced to a pressure somewhat below its popping pressure, no attempt should be made to extinguish the fire which might be burning at the outlet of the relief valve risers. Effort should be directed entirely to controlling the fire around the tank as this is the source of heat creating the pressure within the tank causing the relief valves to operate.

It is desirable to have first aid fire extinguishers handy at all points where there is a possibility of leakage occurring. First aid fire extinguishers of the dry powder type appear to have certain advantages over the carbon dioxide type. Both, however, are very useful in controlling and extinguishing small LP-Gas fires. For large fires, water fog is the most effective.

Years of experience have indicated that LP-Gas may be stored, handled and used with the utmost safety, if proper precautions necessary to the handling of any fuel gas are taken. Evidence of this high degree of safety is apparent from the increased use of LP-Gas by industry in the past few years.

4. AIR CLEANER

All Ford LP-Gas Tractors are equipped with the same type oil bath cleaner used on the gasoline models. For removal, service and installation procedures, refer to page 97, Gasoline Fuel System.

5. CARBURETORS

There are two different model carburetors used on Ford LP-Gas Tractors. Either carburetor may be used on the 134 or 172 cubic inch displacement engine. The early type carburetor was not provided with an integral secondary vaporizer regulator. With this carburetor, the seconday regulator is mounted on the vaporizer, whereas the secondary regulator is an integral part of the carburetor on late models.

The function of the LP-Gas carburetor is the same as the gasoline carburetor, to mix the proper amount of fuel and air for specific engine demands. However, the LP-Gas carburetor has no float nor float valve and seat assembly.

A. Adjustments

The same type adjustments are provided for LP-Gas carburetors as used for adjusting gasoline carburetors. Figure 4 shows the adjustment locations on both the early and late type carburetors. The main adjustment screw lock nut was provided on early type carburetors, therefore, disregard any reference to the lock nut if working on a late type carburetor.

1. For the initial setting before the engine is started, turn the idle fuel adjustment needle clockwise until it seats, then back it off approximately 1-2 turns. Start the engine and again turn the needle clockwise until the engine begins to stall. Back off the needle until the engine operates smoothly.
2. With the hand throttle in the closed position, turn the idle speed adjustment screw (located on engine side of carburetor) until the engine idle speed is 450 to 475 rpm on the Proof-Meter.

   NOTE: ***For new engines it may be necessary to adjust idle speed a little higher to avoid stalling at idle speed.***

3. To obtain the initial main adjustment setting, back off the lock nut, Figure 4, (early carbure-

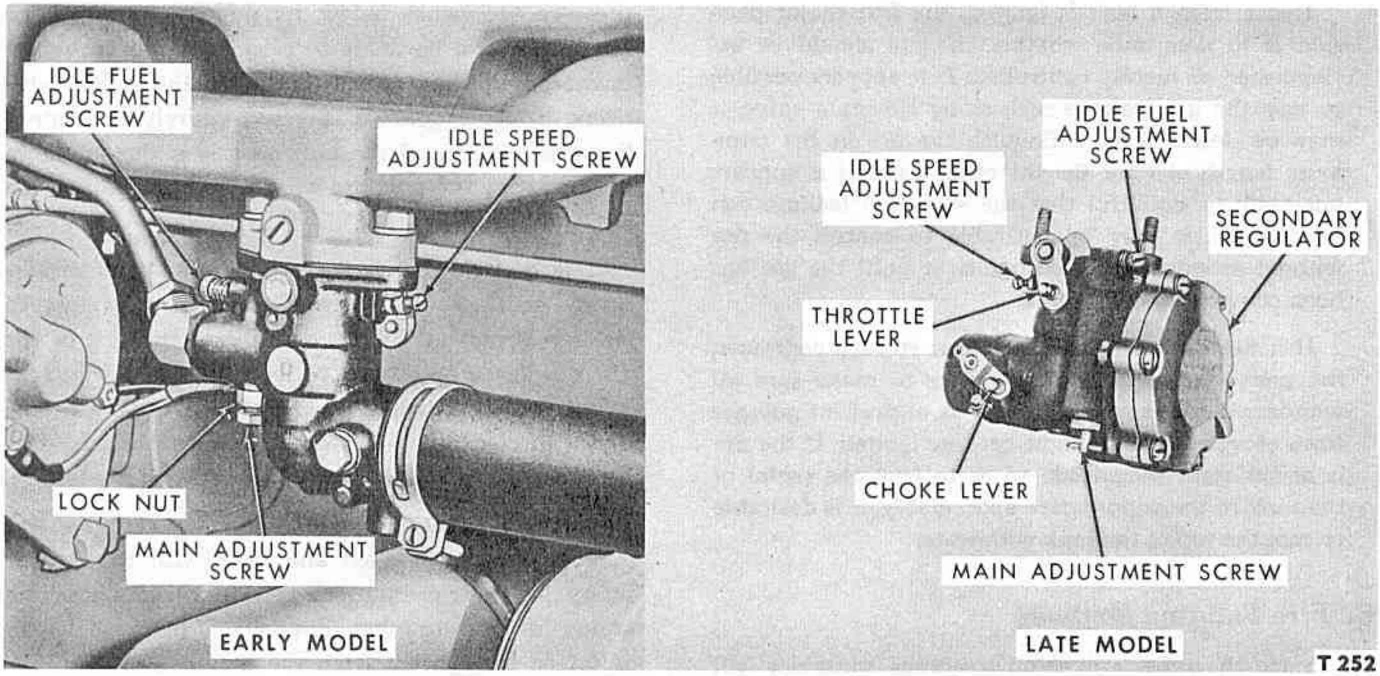

Figure 4—Carburetor Adjustments

tors only) on the main adjustment screw until the nut fully contacts the bottom face of the screw head. Turn the adjustment screw in (clockwise) until it seats. Back off the screw (counterclockwise) 5 full turns and run the lock nut down to lock the adjustment screw in this initial adjustment position.

NOTE: ***On early production tractors, the lock nut, in some instances, cannot be backed fully against the bottom face of the adjustment screw head. When this condition is found, make the initial power setting as follows:***

a. Back the lock nut toward the bottom face of the main adjustment screw as far as the screw threads will permit.

b. Turn the main adjustment screw in the required direction until the distance from the top of the screw head to the screw hole spot face on the carburetor measures ⅝″, then turn the lock nut down until it seats. This adjustment will be the equivalent of five turns for the initial main adjustment screw setting.

Final adjustment should be made in the field under full load engine speed by turning the screw clockwise, until the engine power just begins to drop off, then turn the screw counterclockwise until maximum engine performance is obtained. Lock the screw in position with the lock nut (early type only).

NOTE: ***This final adjustment should be made carefully since it is sometimes difficult to determine where power picks up on LP-Gas engines.***

B. Removal

Make certain that all fuel is burned out of the fuel tank lines, pressure reduction components and carburetor before removing the carburetor. Refer to Figures 5 or 6 for parts identification.

1. Disconnect the fuel line at the carburetor fuel inlet. Disconnect the air cleaner tube. Disconnect the throttle and choke control linkage from the carburetor.
2. Remove the two nuts and lock washers that attach the carburetor to the intake manifold. Discard the manifold connection flange gasket.

C. Disassembly

Complete disassembly instructions are given for both carburetors.

Early Models:

1. Remove the two throttle plate retaining screws and lock washers (1), Figure 5. Remove the throttle plate (3) from the throttle shaft and lever (12).
2. Slip the throttle shaft assembly out of the carburetor.

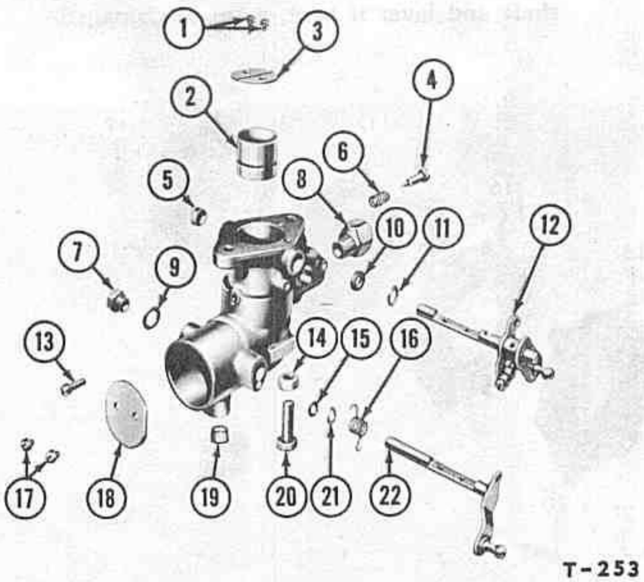

Figure 5—Carburetor Disassembled—Early Type

1. Screws
2. Venturi
3. Throttle Plate
4. Idle Fuel Adjustment Needle
5. Throttle Shaft Plug
6. Spring
7. Choke Shaft Plug
8. Fuel Inlet Connection
9. Gasket
10. Throttle Shaft Seal
11. Throttle Shaft Seal Retainer
12. Throttle Shaft and Lever
13. Screw
14. Lock nut
15. Choke Shaft Seal
16. Choke Return Spring
17. Screws
18. Choke Plate
19. Plug
20. Main Adjustment Screw
21. Choke Shaft Seal Retainer
22. Choke Shaft and Lever

3. Pry out the metal shaft seal retainer (11) with a screwdriver and remove the throttle shaft seal (10).
4. Insert a ¼″ diameter wood dowel approximately 4″ long into the shaft bore to knock out the throttle shaft plug (5) that seals off the opposite end of the shaft bore.

   NOTE: ***The plug removal is not a necessary operation unless the plug is damaged.***

5. Remove the two choke plate retaining screws and lock washers (17). Remove the choke plate (18) from the shaft.
6. Slide the choke shaft and lever (22) out of the carburetor and remove the choke shaft seal (15), retainer (21) and choke return spring (16).
7. Remove the threaded choke shaft plug (7), and fiber gasket (9) from the opposite end of the shaft.
8. Remove the venturi attaching screw (13) and lift the venturi (2) out of the carburetor. Note that the step in the counter bore of the venturi faces toward the carburetor mounting flange.
9. Loosen the main adjustment screw lock nut (14) and back the main adjustment screw (20) out of the bore.
10. Remove the idle fuel adjustment needle (4) and spring (6) by turning it counterclockwise out of the carburetor.

Late Models:

1. Remove the two throttle plate attaching screws and lock washers (12), Figure 6, and remove the throttle plate (11).
2. Remove the idle fuel adjustment needle (20) and spring (21).
3. Slip the throttle shaft and lever (26) out of the carburetor.
4. Carefully pry the throttle shaft seal retainer (25) and seal (24) from the carburetor with a punch.
5. Remove the venturi retaining screw (28) then carefully lift the venturi (10) out of the carburetor.
6. Disconnect the choke lever return spring (31) from the pin on the carburetor. Remove the two choke plate retaining screws and lock washers (1). Slip the choke lever and shaft (32) out of the carburetor then remove the choke plate (2).
7. Remove the six diaphragm attaching screws and lock washers (19) and diaphragm parts (14 through 18). Separate the parts as shown in Figure 6.
8. Remove the fuel valve axle retainer (9), fiber washers (8), axle (7) and fuel valve lever (13).
9. Loosen the inlet orifice set screw (22), Figure 6, with an Allen wrench. Remove the inlet orifice, Figure 7, from the carburetor with a wide screwdriver. Remove the inlet valve (39) and spring (40), Figure 6.
10. Remove the main jet adjustment needle (35), Figure 6, from the lower end of the carburetor.
11. Remove the main jet as shown in Figure 8.

D. Cleaning and Inspection

1. Clean all metal parts thoroughly in cleaning solvent and dry with compressed air.
2. Blow out all passages in the carburetor body to remove dirt and foreign material.

3. Replace the complete carburetor if the carburetor body is cracked or damaged.
4. Replace the idle fuel adjustment needle if the seat is ridged or if the threads are damaged.
5. Replace the main adjustment screw if bent or if the threads are damaged.
6. Replace the choke and lever shaft or throttle shaft and lever if bent, worn or damaged.

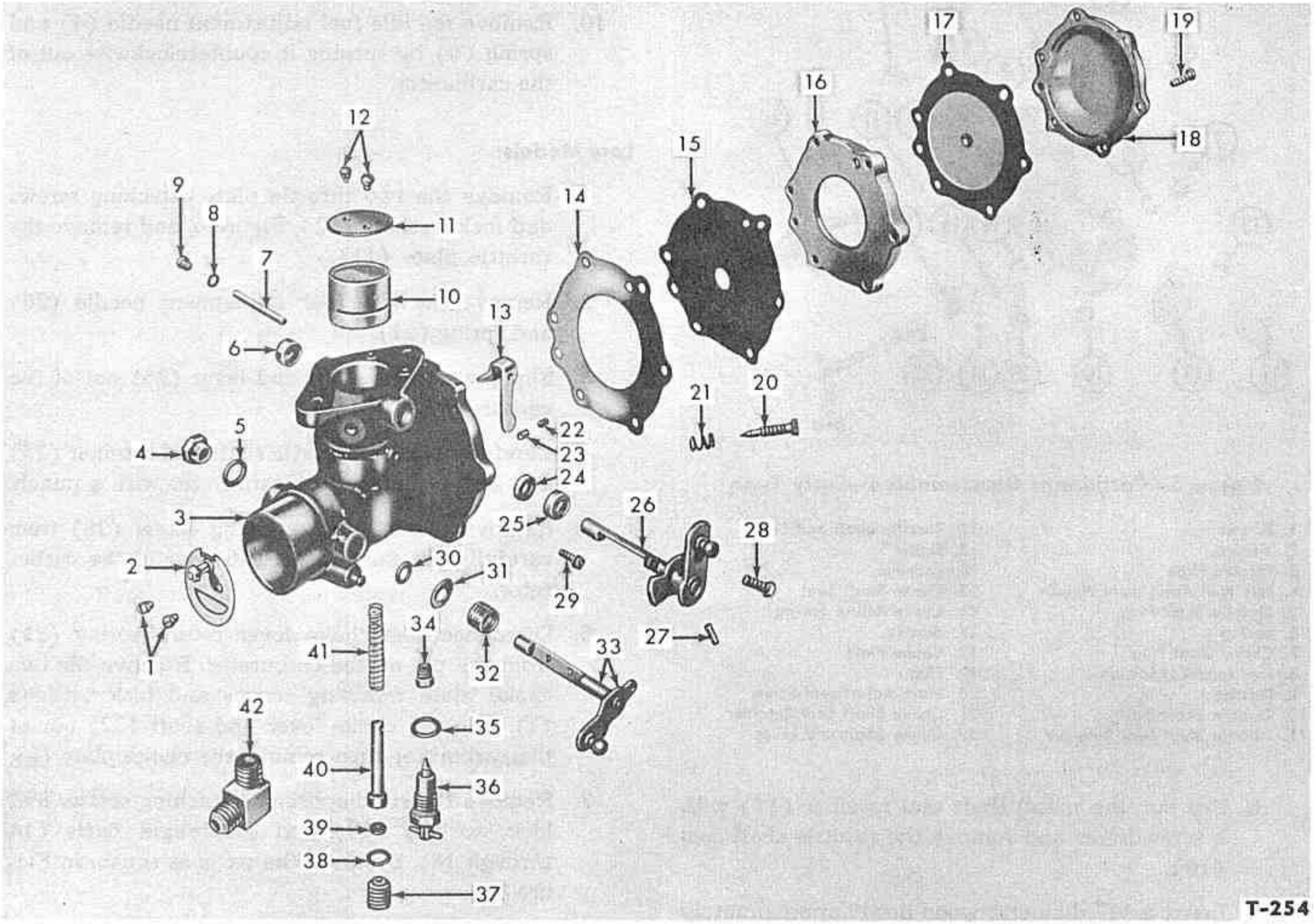

Figure 6—Carburetor—Disassembled—Late Type

1. Screw
2. Choke Plate
3. Carburetor Body
4. Plug
5. Fiber Washer
6. Plug
7. Diaphragm Lever Axle
8. Fiber Washer
9. Screw
10. Venturi
11. Throttle Plate
12. Screw
13. Diaphragm Lever
14. Gasket
15. Inner Diaphragm
16. Diaphragm Spacer
17. Outer Diaphragm
18. Diaphragm Cover
19. Screw
20. Idle Fuel Adjustment Needle
21. Spring
22. Set Screw
23. Nylon Plug
24. Throttle Shaft Seal
25. Throttle Shaft Seal Retainer
26. Throttle Lever and Shaft
27. Throttle Lever Pin
28. Idle Speed Adjustment Screw
29. Screw
30. Choke Shaft "O" Ring
31. "O" Ring Retainer
32. Choke Lever Return Spring
33. Choke Lever and Shaft
34. Main Jet
35. Fiber Washer
36. Main Jet Adjustment
37. Inlet Orifice
38. Inlet Orifice "O" Ring
39. Orifice Seat
40. Fuel Valve
41. Spring
42. Fuel Inlet Elbow

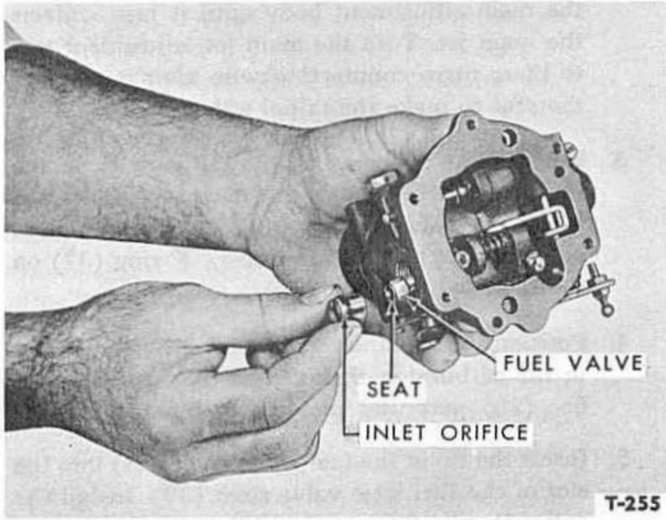

Figure 7—Removing Inlet Orifice

7. Replace the venturi if bent or damaged.
8. Replace a damaged throttle or choke plate.
9. Replace all seals, retainers and diaphragms at time of overhaul.

E. Assembly

Early Models:

1. Install both fuel adjustment screws (4) and (20), Figure 5, in their respective orifices using the lock nut (14) on the main adjustment screw and spring (6) on the idle fuel adjustment needle.
2. Position the venturi (2) into the carburetor body so that the step in its counterbore faces upward. If it is installed in reverse, the venturi slots will not align with the fuel intake passages of the carburetor.
3. Ream the choke and the throttle shaft bores at the points where previous "staking" of the metal was used to hold the shaft seal retainers in place. Clean the shaft hole counterbores thoroughly. Position a new throttle shaft seal into the counterbore so that the sealing lips face outward as shown in Figure 9. Work the seal into the bore using a pencil or similar item.

   Place a new seal retainer (11), Figure 5, over the seal and drive it gently into position with a blunt tool, not over $\frac{7}{16}$ inch in diameter. The retainer should be $\frac{1}{8}$ inch below the top of the

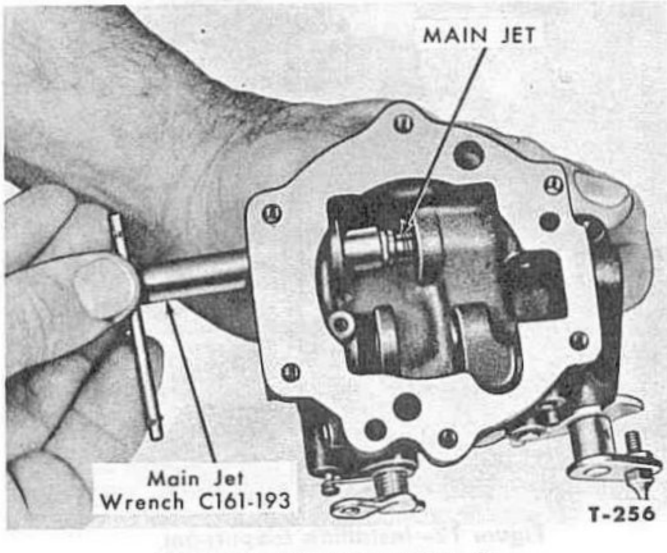

Figure 8—Removing Main Jet

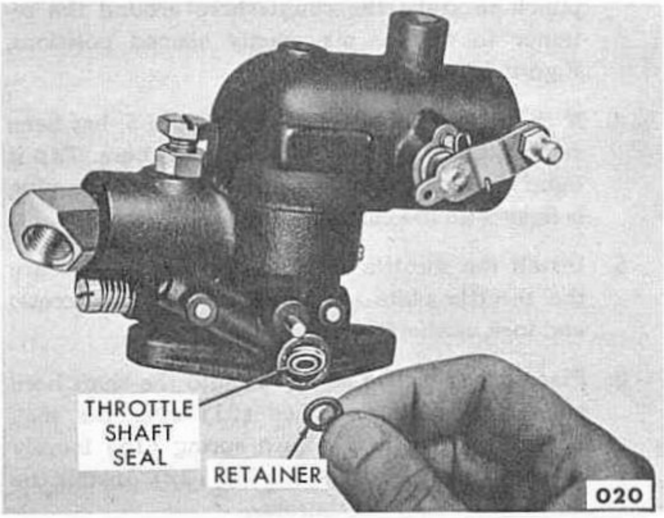

Figure 9—Installing Throttle Shaft Seal and Retainer

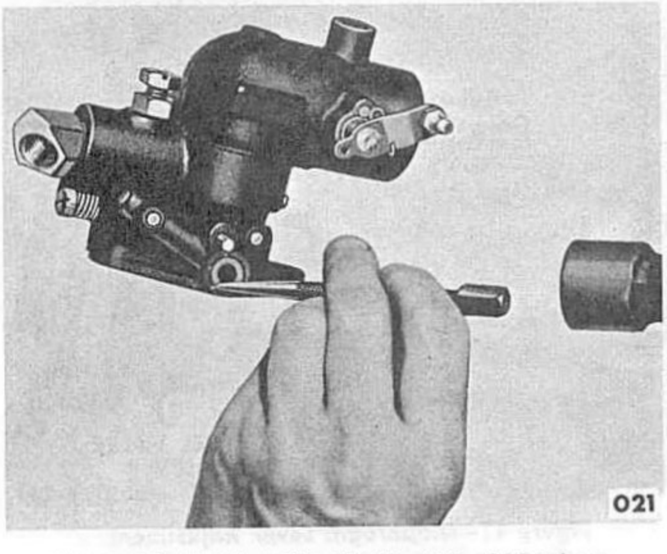

Figure 10—Staking Throttle Shaft Seal Retainer

bore when properly positioned. Use a prick punch to stake the counterbore around the retainer in five or six evenly spaced positions, Figure 10.

4. If the throttle shaft plug (5), Figure 5, has been removed, press a new plug into the bore. Tap it lightly with a hammer until the top of the plug is flush with the casting.

5. Install the throttle shaft and lever (12). Secure the throttle plate to the shaft with two screws and lock washers (1).

6. Place a new choke seal (15) into the shaft bore and position the retainer (21) over the seal. Assemble the choke return spring (16) loosely on the throttle shaft and lever (22). Install the choke shaft in the carburetor.

7. Position a new gasket (9), Figure 5, on the choke shaft plug (7) and install the plug in the carburetor.

8. Install the choke plate (18) on the choke shaft (22) with two screws and lock washers (17). Hook the choke return spring over the choke lever at one end and attach the other end to the screw provided in the boss, just under the choke lever shaft.

Late Models:

1. Install the main jet as shown in Figure 8.

2. Position a new fiber washer (34), Figure 6, on the main adjustment jet body (35). Install the jet body in the carburetor. Place a new "O" ring on the main adjustment and thread it into the main adjustment body until it just contacts the main jet. Turn the main jet adjustment two to three turns counterclockwise after it contacts the seat to make the initial adjustment.

3. Replace the rubber seat (38), Figure 6, on the fuel inlet valve stem with a new seat. Place the fuel inlet valve spring (40) on the fuel inlet valve stem (39). Install a new "O" ring (37) on the inlet valve orifice (36).

4. Position the fuel inlet valve and spring assembly in the carburetor, then thread the fuel inlet orifice (36) part way into the carburetor.

5. Insert the tip of the fuel valve lever (13) into the slot of the fuel inlet valve stem (39). Install the axle (7), new fiber washer (8) and axle retainer (9) in the carburetor.

6. Place Adjustment Gauge C161-194 on the diaphragm mounting surface as shown in Figure 11. Turn the fuel inlet orifice as necessary until the tip of the fuel valve lever contacts the gauge. Secure the fuel inlet orifice (36), Figure 6, with a new nylon plug (23) and set screw (22).

7. Install the three Aligning Studs C 166-52 in the carburetor as shown in Figure 12. Position the gasket on the studs making sure that the vacuum channel hole and the vent channel hole in the gasket are in alignment with the passages in the carburetor. Install the inner diaphragm (15), Figure 6, on the studs with the spacer cup out. Install the diaphragm spacer (16) with the recessed side out. Install the outer diaphragm

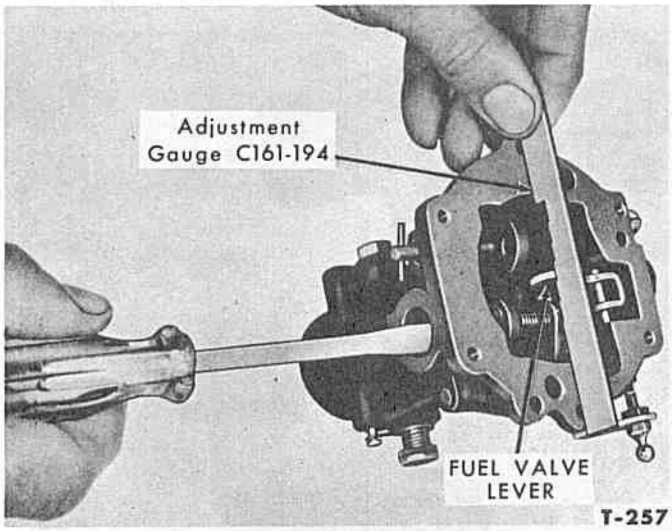

Figure 11—Diaphragm Lever Adjustment

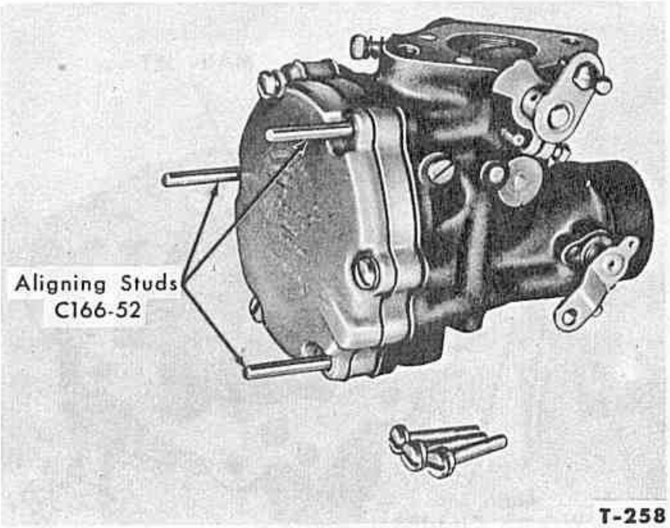

Figure 12—Installing Diaphragm

(17) with the diaphragm plate in. Install the diaphragm cover and secure with three attaching screws and lock washers. Remove the three aligning studs, then install the three remaining diaphragm attaching screws.

8. Install the venturi (10), Figure 6, in the carburetor with the annulus pickup tube facing toward the diaphragm.
9. Carefully install a new throttle shaft seal (24) and retainer (25). Install a new throttle shaft bore plug (6) if it was removed.
10. Position the throttle shaft and lever assembly (26) in the carburetor so that the idle speed adjustment screw (27) contacts the stop. Position the throttle plate (11) on the throttle shaft so that the numbers "02" on the plate are up and toward the diaphragm. Secure the plate to the shaft with two screws and lock washers (12).
11. Install the idle fuel adjustment needle (20) and spring (21). Turn the screw in until it just bottoms, then back it out 1-1½ turns to make the initial adjustment.
12. Hold the choke plate (2) in position with the relief valve spring facing out and downward, then slip the choke shaft and lever (32) into place. Secure the choke plate to the shaft with two screws and lock washers (1). Connect the choke return spring to the lever and pin.

F. Installation

Before installing the carburetor, install the fuel line connectors using a non-hardening pipe thread sealer on the threads.

1. Position a new gasket over the mounting studs and install the carburetor on the intake manifold using the two nuts and lock washers.
2. Install the fuel line between the carburetor and vaporizer or regulator.
3. Connect the throttle and choke linkage and install the air cleaner connector tube to the carburetor air intake.
4. Adjust the carburetor as detailed in Paragraph A.

6. FUEL TANK, VALVES AND LINES

Tank components that may be serviced are the fuel withdrawal, overflow, relief and filler valves, and the fuel gauge. The fuel tank must be returned to the manufacturer for servicing if it is defective or if welding is required.

A defective fuel tank must be removed from the tractor and stripped of all lines, gauge and valves, and the fuel filter.

Tank identification is given on the manufacturer's plate as shown in Figure 13.

Prior to servicing any of the valves that are mounted directly on the fuel tank, any fuel remaining in the tank must be disposed of. Fuel removal is best accomplished by driving the tractor into a large open area or field, AWAY from buildings. Disconnect the lines at the withdrawal valves and open the valves slowly to prevent the integral "excess flow" valves from closing off the fuel flow. Allow the gas to vent into the air until the fuel is exhausted.

Take the necessary safety precautions and fire preventative measures to insure control of the operation.

After the tank has been emptied, reinstall the lines to the withdrawal valve connections and close the valves. The tractor may then be driven to the stall by using portable bottle gas.

A. Fuel Tank Removal

1. Remove the hood and side panels from the tractor after disconnecting the headlamp wires.
2. Disconnect the flexible hose at the vaporizer inlet and pull it up through the heat deflector shield.

CAUTION: ***Before disconnecting any fuel line, make certain that both fuel withdrawal valves are closed and that the engine has been operated long enough to use all fuel in the lines.***

3. Remove the four tank mounting bolts, nuts, and lock washers which secure the tank to the tank mounting brackets, Figure 14.
4. Remove the instrument cable clip bracket at the right rear bracket bolt location.
5. With an assistant, lift the tank from the heat deflector shield.

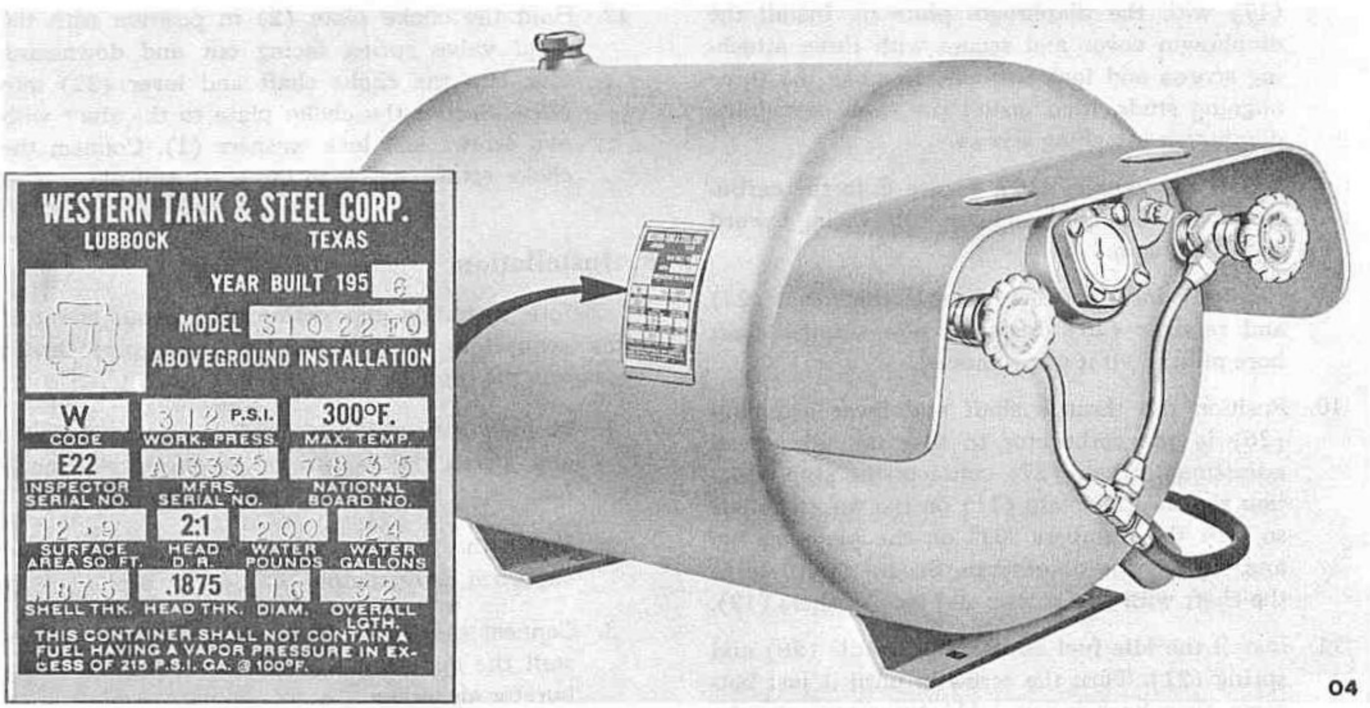

Figure 13—LP-Gas Fuel Tank Removed

B. Valves, Lines and Gauge Removal

1. Disconnect the fuel lines at the withdrawal valves, Figure 1, and at the auxiliary fuel connection on the right side of the tank.

2. Turn the valve assemblies counterclockwise to remove them from the tank.

3. Remove the four screws that attach the fuel gauge to the tank. Tap the sides of the gauge housing lightly with a soft hammer to free it from the gasket. Carefully lift the gauge from the tank.

4. Unscrew the filler valves, vapor return valve and relief valve from the tank.

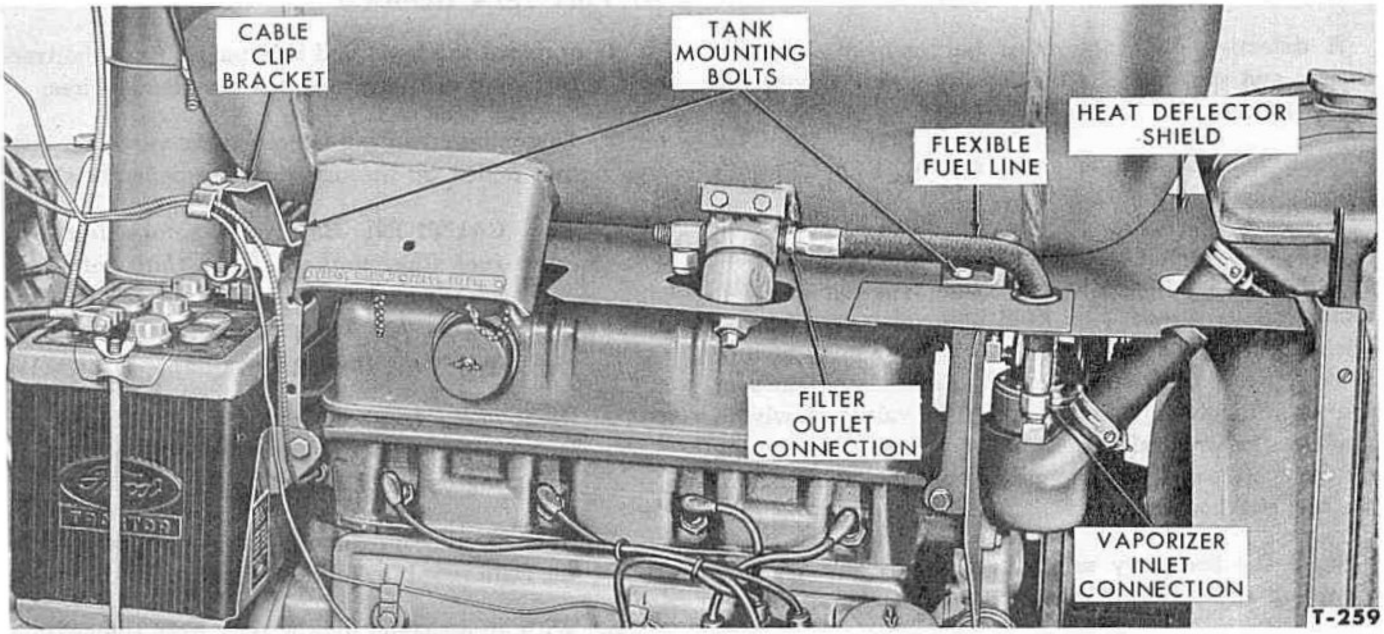

Figure 14—Fuel Tank Mounting

5. Remove the two nuts, bolts and lock washers that attach the fuel filter to the mounting bracket, then remove the filter.

C. Inspection

1. Inspect the tank for broken welds (at mounting brackets), damaged threads, and fittings. Return the tank to the manufacturer for repair if any broken welds are noted.
2. Replace all valves that were leaking or that appear to be defective.
3. Replace a damaged or defective fuel gauge.

D. Valves, Lines and Gauge Installation

1. Apply a light film of non-hardening type pipe thread sealer on all valve threads and fuel line connections.
2. Install the vapor withdrawal valve on the left side of the tank and the liquid withdrawal valve on the right side as shown in Figure 1. Make certain that the valves are turned so that the fuel line connections on the valves are in alignment with the fuel line. Install a new rubber tube over the fuel line at the point where it passes over the battery.
3. Position the fuel gauge and new gasket on the fuel tank and secure in place with the four attaching screws. Make certain that the numerals on the gauge are in the upright position.

   NOTE: ***There are two different fuel gauges used on the LP-Gas fuel tanks. Both gauges are installed in the same manner.***
4. Thread the two filler valves and relief valve into the fuel tank.
5. Secure the fuel filter to the mounting bracket with two bolts, nuts and lock washers.
6. Connect the fuel lines to the withdrawal valves and fuel filter.
7. With an assistant, position the fuel tank on the mounting brackets. Secure the tank to the brackets with four mounting bolts, nuts and lock washers, Figure 14. Secure the cable clip bracket to right rear tank mounting bracket. Secure the oil line and temperature gauge tube to the cable clip bracket.
8. Thread the flexible fuel line through the heat shield and connect it to the vaporizer inlet fitting.
9. Install the hood and side panels on the tractor. Connect the headlamp wires to the bullet type connectors.

7. FUEL FILTER

Removal of the fuel filter from the fuel tank is covered under fuel tank removal The maintenance of the fuel filter is covered in this section.

A. Filter Element Removal

1. Burn off all fuel in the system except the tank by starting the engine and then closing off the fuel withdrawal valves. Permit the engine to run until the fuel in the lines is completely exhausted and the engine stops, then turn off the ignition key.
2. Remove the filter cover by turning it in a counterclockwise direction with a wrench.
3. Remove the filter element by turning it counterclockwise by hand.

   NOTE: ***If the element cannot be turned by hand, grasp the square shaft, Figure 15, with pliers and turn it out of the base. Be careful not to damage the metal discs when removing the element.***

B. Inspection and Cleaning

Replace the filter element if there is any evidence of bent or damaged discs. The discs must be flat for proper filtering action of the element.

1. If the element shows no signs of damage, rinse it thoroughly in a clean solvent.
2. Flush the element with an air hose, making sure that the air stream is directed through the length of the element as shown in Figure 15.

   IMPORTANT: ***Do not direct the air stream to the sides of the element as disc damage can occur due to the force of the air stream.***

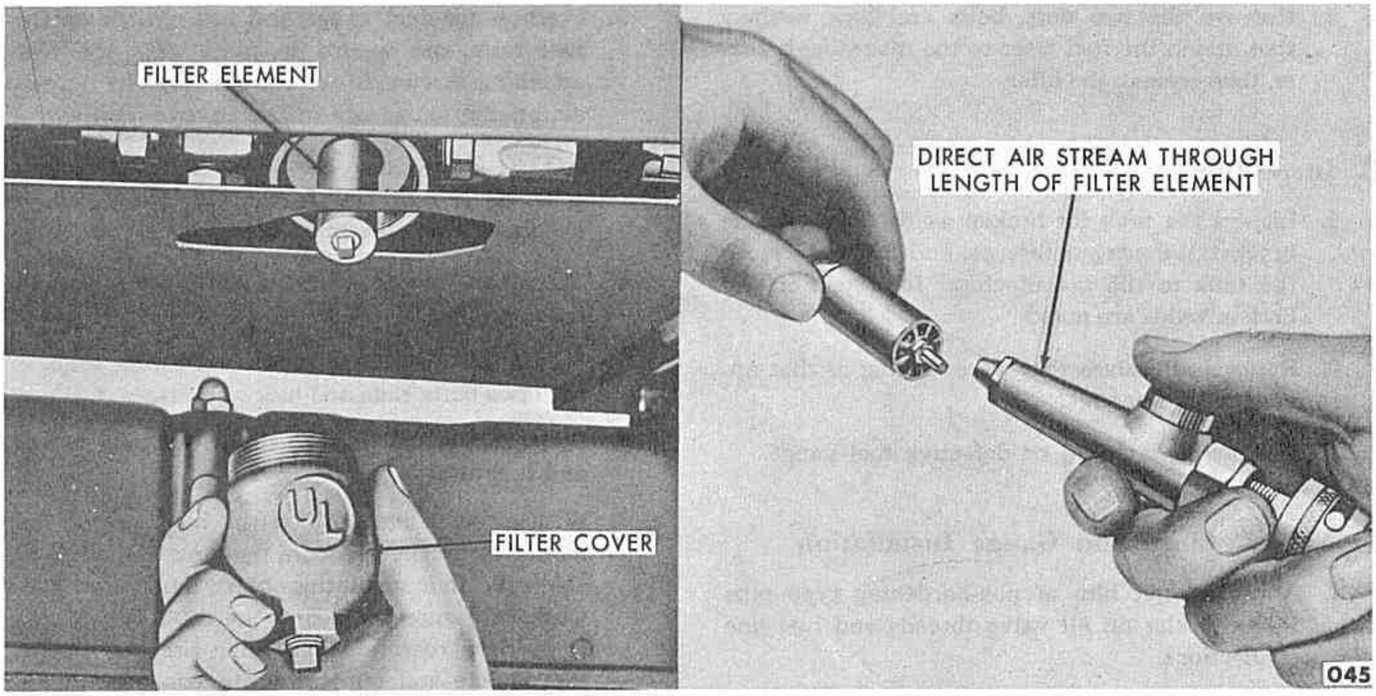

Figure 15—Servicing the Fuel Filter

C. Installation

1. Install the filter element FINGER TIGHT to prevent disc jamming.
2. Clean the filter cover thoroughly to remove any sediment and reinstall using a new neoprene gasket, being careful not to nick the filter element. Tighten with a wrench.

8. PRESSURE REGULATOR AND VAPORIZER

Tractors having a late model carburetor (one with an integral secondary regulator) will not have a secondary regulator mounted on the vaporizer.

A. Removal

1. Burn off all fuel in the system except the tank by starting the engine and then closing off the fuel withdrawal valves. Permit the engine to run until the fuel in the lines is completely exhausted and the engine stops, then turn off the ignition
2. Drain the radiator. Loosen the clamp that secures the radiator upper hose to the vaporizer water jacket, Figure 16. Disconnect the upper hose from the water jacket.
3. Disconnect the flexible fuel line from the vaporizer. Disconnect the fuel line from the pressure regulator (early models only). The fuel line will be connected directly to the vaporizer on late models.
4. Turn the bolt that secures the vaporizer to the water jacket approximately three turns counterclockwise. Strike the bolt with a soft hammer, Figure 16, to free the vaporizer from the water jacket. Remove the bolt and washer, then lift the vaporizer assembly from the water jacket.
5. Separate the vaporizer from the pressure secondary regulator by turning each unit off the connecting nipple (early models only).

B. Disassembly

Vaporizer—Early Models:

1. Remove the inlet valve seat retainer and the aluminum washer from the inlet valve seat bore, Figure 17.
2. Loosen the lock nut on the pressure adjusting screw and turn this screw all the way down to depress the inlet valve seat. The valve seat in its

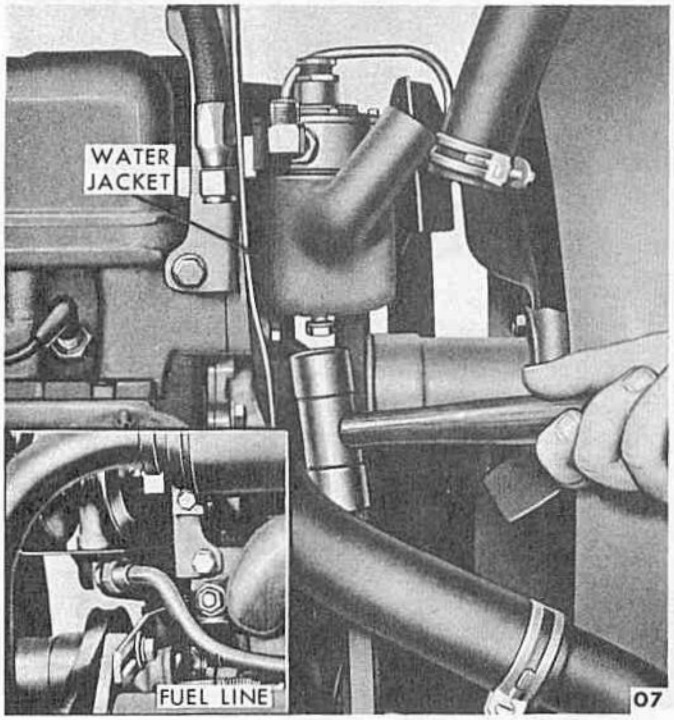

Figure 16—Removing Vaporizer

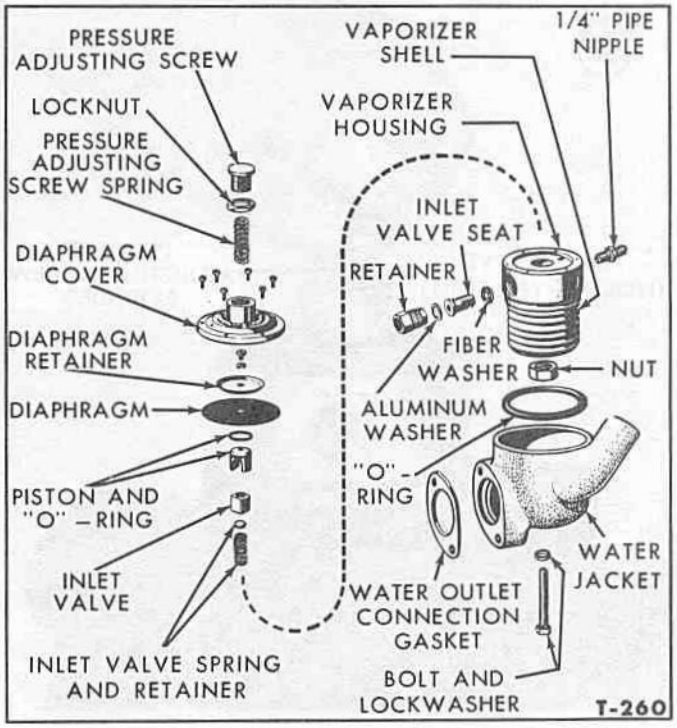

Figure 17—Vaporizer Disassembled—Early Model

normal position interferes with the removal of the inlet valve, (A), Figure 18.

3. Screw a ¼-20 bolt into the inlet valve, (B), Figure 18, and remove the valve.

4. Lift the rubber diaphragm with the assembled piston from the bore. Remove the screw that secures the diaphragm and retainer to the piston and discard the rubber diaphragm.

5. Invert the vaporizer assembly and remove the inlet valve seat, spring and spring cap.

6. Remove the large "O" ring from its groove on the outside of the vaporizer housing.

7. Remove the steel screw and fiber washer that secures the vaporizer shell to the vaporizer body. Separate the shell from the body and remove the "O" ring.

8. Wash all metal parts thoroughly with cleaning solvent and dry them. Discard all "O" rings.

Pressure Regulator—Early Models Only:

1. Disconnect the air balance line from the "tee" connector and from the 90° connector, Figure 19.

2. Remove the 90° elbow and lock nut from the lower end of the regulator then remove the deflector shield.

3. Turn each diaphragm counterclockwise until free of the regulator.

4. Remove the two valve stem spring retaining screws from the housing.

5. Remove the regulator adjusting screw by backing it out of the bore with a screwdriver. Remove the "O" ring from the adjusting screw.

6. At the opposite end of the housing, back off and remove the fuel regulator valve retainer and slide the valve assembly from the bore of the housing.

NOTE: ***Never back off the valve retainer without first removing or loosening the two retainer screws at the opposite end of the housing. If the retainer screws are tight, the leaf springs on the valve assembly will twist.***

7. Remove the valve seat (rubber washer) from the valve assembly.

8. Wash all metal parts in cleaning solvent except the diaphragm assemblies. Wipe the diaphragms clean with a damp cloth.

Vaporizer—Late Model:

1. Remove the four screws (11), Figure 20, that attach the vaporizer coil and mounting plate (1)

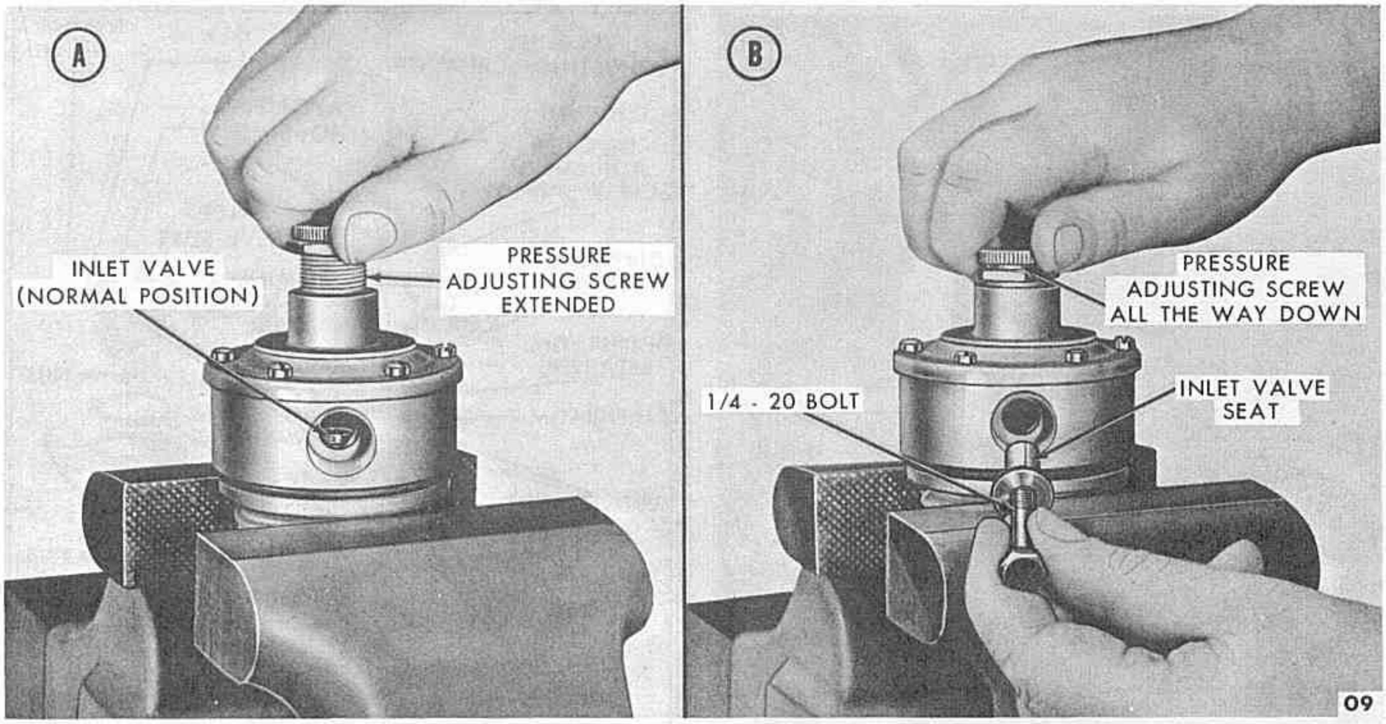
(A)
INLET VALVE (NORMAL POSITION)
PRESSURE ADJUSTING SCREW EXTENDED
(B)
PRESSURE ADJUSTING SCREW ALL THE WAY DOWN
INLET VALVE SEAT
1/4 - 20 BOLT
09

Figure 18—Removing Vaporizer Inlet Valve

to the vaporizer body (13). Separate the coil from the body and discard "O" rings (2) and (6).

2. Remove every other one of the four diaphragm cover attaching screws (19). Install four Aligning Studs C161-195 as shown in Figure 21. Maintain pressure on the diaphragm cover and remove the four remaining screws.
3. Release the pressure on the diaphragm cover and remove the cover (10), Figure 20, inner spring (8), outer spring (9), and vibration dampener (18). Remove the four Aligning Studs C161-195 from the vaporizer body.
4. Lift the diaphragm (17), baffle plate (7), gasket (16), and fuel valve cap (6), from the body.
5. Remove the fuel valve seat (15), "O" ring (5) from the body with a 1" socket wrench. Lift the fuel valve (14) and spring (4) from the body.

C. Inspection

Vaporizer—Early Model:

1. Replace the inlet valve if damage is evident at the shoulder.
2. Replace the inlet valve seat if bent or damaged.
3. Replace the complete vaporizer assembly if the body is damaged.
4. Replace the cover if the threads are damaged or if the cover is distorted.
5. Replace the vaporizer shell if punctured, distorted or if the sealing surface is damaged.

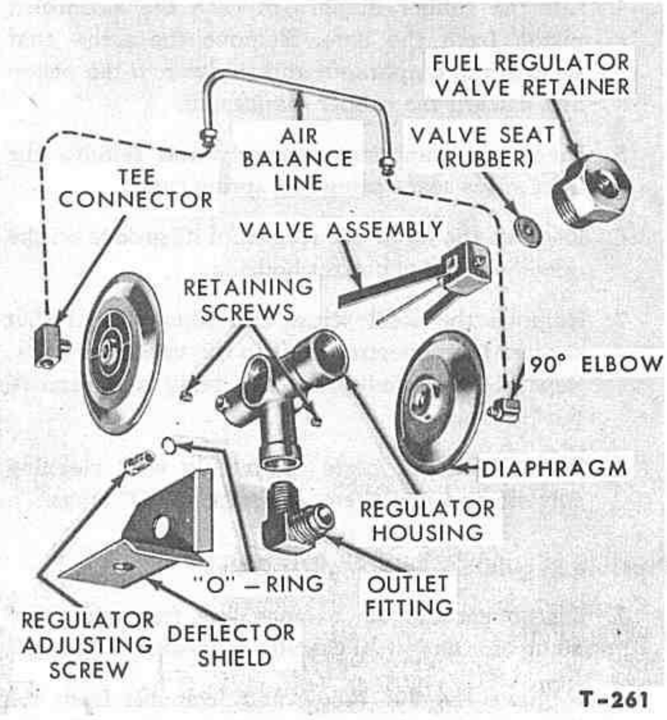

Figure 19—Pressure Regulator Disassembled

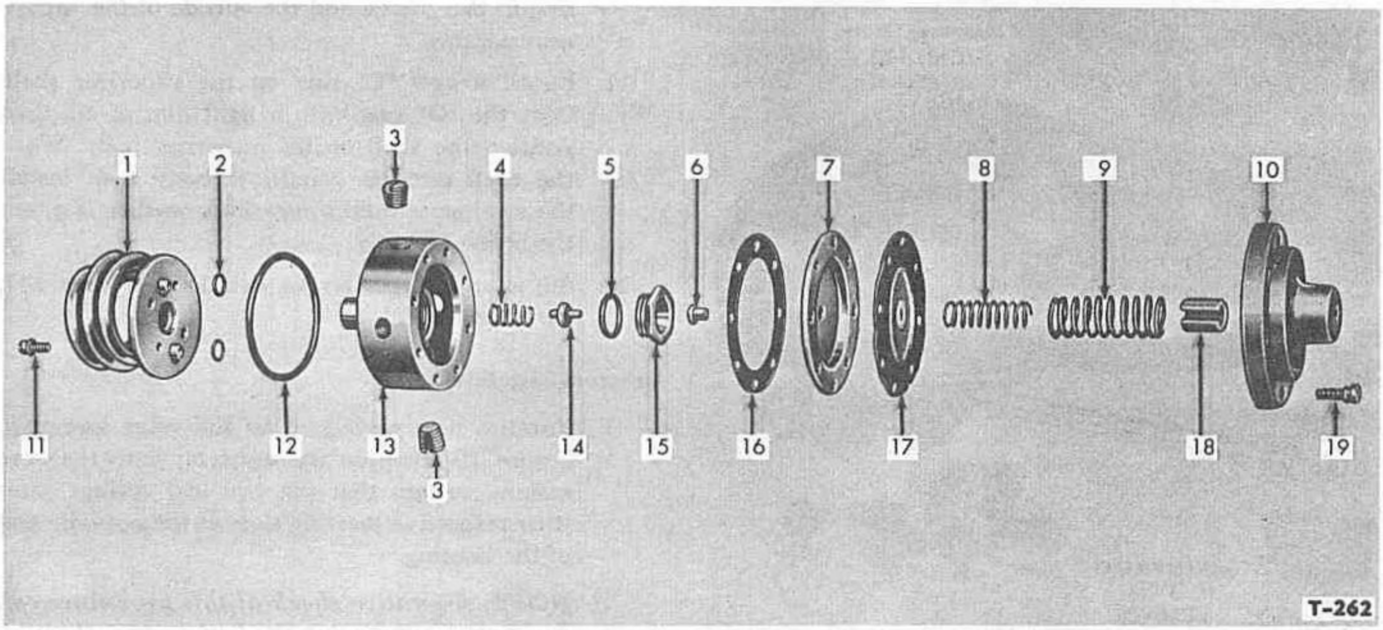

Figure 20—Vaporizer Disassembled—Late Model

1. Coil and Mounting Plate
2. Vaporizer Coil "O" Ring
3. Plug
4. Fuel Valve Spring
5. Valve Seat "O" Ring
6. Fuel Valve Cap
7. Baffle Plate
8. Diaphragm Inner Spring
9. Diaphragm Outer Spring
10. Diaphragm Cover
11. Screw
12. Water Casting "O" Ring
13. Vaporizer Body
14. Fuel Valve
15. Valve Seat
16. Gasket
17. Diaphragm
18. Vibration Dampener
19. Screw

6. Replace broken or bent springs.
7. Replace all "O" rings, inlet valve seat disc, diaphragm and inlet valve seat retaining washer at every overhaul.

Pressure Regulator:

1. Replace the diaphragms if bent, damaged or if they leak.
2. Replace the valve stem assembly if the leaf springs are twisted or have taken a definite inward set.
3. Replace the valve stem spring retaining screws if the nylon tips are flat or damaged.
4. Replace all damaged or stripped fittings.
5. Replace the complete regulator if the body is cracked or damaged.
6. Replace the air balance tube if bent or cracked.

Vaporizer—Late Model:

1. Replace the diaphragm outer spring (9), Figure 20, inner spring (8), diaphragm (17), gasket (16), "O" rings (5, 12, and 2), fuel valve (14) and fuel valve springs (4) at time of overhaul.
2. Replace the coil and mounting plate (1), body (13), baffle plate (7), or cover (10) if damaged.

D. Assembly

Vaporizer—Early Model:

1. Position a new rubber diaphragm over the piston and lay the retainer (flange up) on the diaphragm. Secure these units with the diaphragm screw, but do not tighten at this time.
2. Insert the inlet valve seat into its bore temporarily. This valve has a slot that engages a dowel pin located in the bore to prevent the valve seat from being installed improperly.
3. Install four Aligning Studs C166-51 in the vapporizer body. Position the assembled diaphragm and piston over the alignment studs and into the bore so that the piston straddles the inlet valve without rubbing against it.
4. Tighten the diaphragm screw. Hold the diaphragm and retainer to keep them from moving when tightening the screw.
5. Remove the assembled diaphragm and piston plus the inlet valve from their respective bores after proper alignment has been determined.

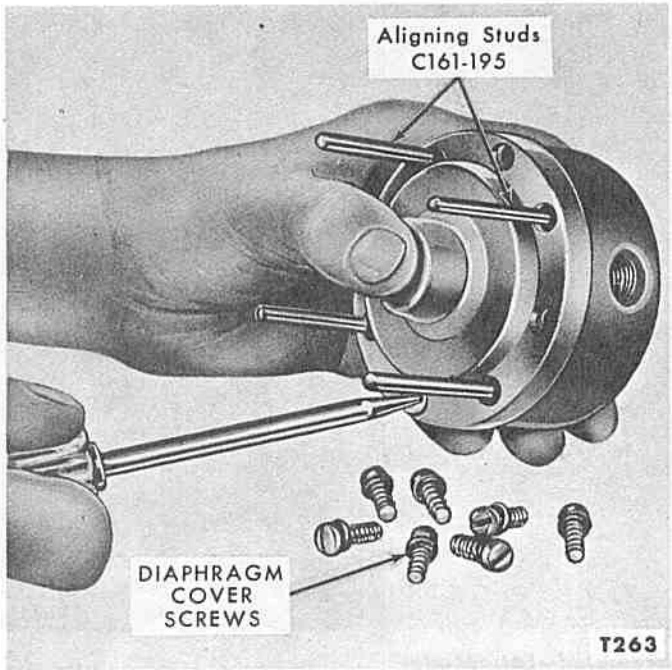

Figure 21—Removing Diaphragm Cover

6. Place the spring retainer on the spring and insert the retainer end of the spring into the inlet valve. Assemble these units into the bore as shown in Figure 17.

7. Install the assembled diaphragm and piston over the alignment studs and into the bore after installing a new "O" ring on the piston. Coat the "O" ring with a light film of oil for easier installation. Recheck the piston alignment by sighting into the inlet valve bore. The yoke of the piston should line up with the inlet bore, and the six diaphragm holes should align with the holes in the top of the vaporizer body.

8. Install the cover over the studs and diaphragm and secure it with two diaphragm screws. Remove the four aligning studs and install the remaining four attaching screws. Place the adjusting screw spring into the bore through the top of the cover and install the adjusting screw and lock nut.

9. Turn the adjusting screw all the way in to depress the inlet seat.

10. Install a new "O" ring on the inlet valve and insert the valve in the bore using the slot as a guide. Remove the ¼-20 bolt from the assembled valve.

11. Place a new aluminum washer into the valve bore. Thread the inlet valve seat retainer into the bore and tighten. Install a new large "O" ring in the groove and the outside of the vaporizer assembly.

12. Install a new "O" ring on the vaporizer shell. Coat the "O" ring with a light film of oil, then position the shell on the vaporizer body. Work the shell into the vaporizer body then install the steel screw and a new fiber washer. Tighten the screw securely.

13. Adjust the vaporizer as detailed on page 147, paragraph E.

Pressure Regulator:

1. Install a new valve seat on the valve assembly, Figure 19. Position the assembly into the bore making certain that the two leaf springs enter their respective locating slots at the opposite end of the housing.

   NOTE: ***A positive check of this procedure can be made by observing the leaf springs through the two retaining screw holes in the housing.***

2. Invert the housing to prevent the valve assembly from falling out. Recheck the seating of the leaf springs in the slots and install the retainer and tighten securely.

   IMPORTANT: ***Do not secure the leaf springs in their slots with the two retaining screws until the next step has been completed. To do so will render the valve inoperative.***

3. Lubricate a new "O" ring with a light film of oil and install it on the pressure adjusting screw. Invert the housing so that the valve retainer faces downward as shown in Figure 22 and install the pressure adjusting screw. Be certain that the stem of the valve stem assembly enters the hole of the pressure adjusting screw before turning the screw inward.

   IMPORTANT: ***It is possible to install the pressure adjusting screw without the stem being located in the hole. If this occurs the valve will be jammed tightly against the valve retainer with a result of broken or locked valve parts. To determine if the valve stem is properly engaged in the hole of the pressure adjusting screw, check by sighting through the diaphragm mounting holes. When proper engagement has been assured, turn the pressure adjusting screw all the way in so that it seats lightly.***

4. Inspect the nylon seats of the two retainer screws. Normally these seats are rounded and become partially flattened after contact with the

leaf springs. If these seats are extremely flattened replace the retainer screws.

5. Position the regulator housing so that the valve retainer faces downward with the installed valve assembly resting on it. Use a depth gauge as shown in insert (B), Figure 22, to depress each spring to $^{11}/_{32}$". With the spring held in the depressed position by the depth gauge, lock the leaf spring in its slot with a retainer screw. Follow the same procedure for the other leaf spring.

   IMPORTANT: ***Step 5 must be followed to insure the proper seating of the valve and to compensate for valve seat wear.***

6. Install the two interchangeable diaphragm assemblies on the housing, hand tight.

   NOTE: ***Before further assembly of the regulator is attempted, refer to insert A in Figure 22 which shows both pressure reduction components completely assembled for installation on the tractor. Refer to this insert when completing the assembly of the regulator. Replace any of the connectors with damaged threads and use a non-hardening pipe sealer at all connections.***

7. Connect the partially assembled regulator to the vaporizer assembly with the threaded nipple.

8. Position the smaller hole in the deflector shield over the outlet port of the regulator and secure it in position with the 90° fuel line connector and the lock nut.

9. Install the 90° elbow through the hole in the front of the deflector shield and thread it into the front diaphragm. Install the "tee" connector in the rear diaphragm.

   NOTE: ***One end of the "tee" is equipped with a screen. This end, vented to atmosphere, must be downward, or opposite the balance tube end.***

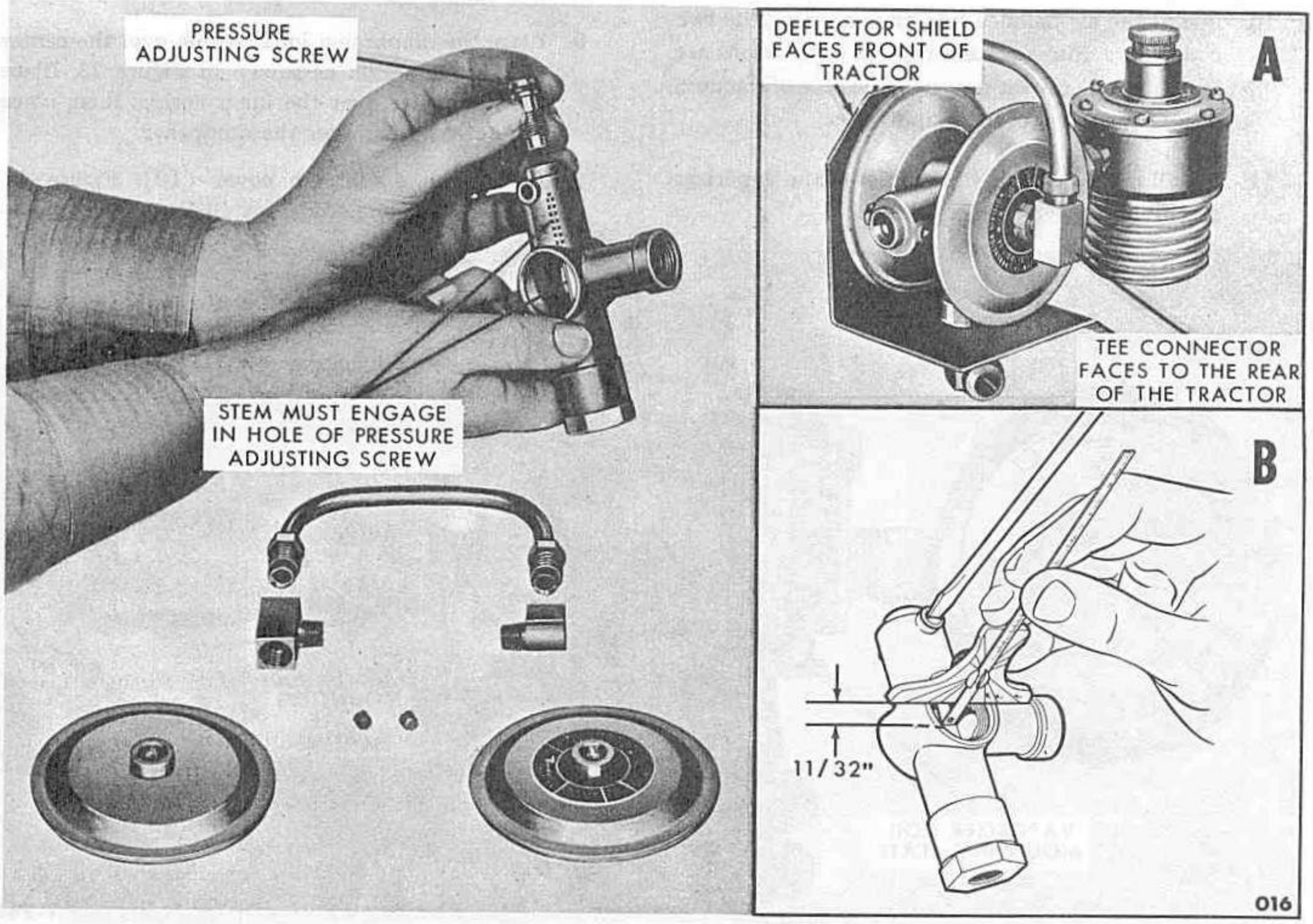
PRESSURE ADJUSTING SCREW
STEM MUST ENGAGE IN HOLE OF PRESSURE ADJUSTING SCREW
DEFLECTOR SHIELD FACES FRONT OF TRACTOR
A
TEE CONNECTOR FACES TO THE REAR OF THE TRACTOR
B
11/32"
016

Figure 22—Installing Pressure Adjusting Screw

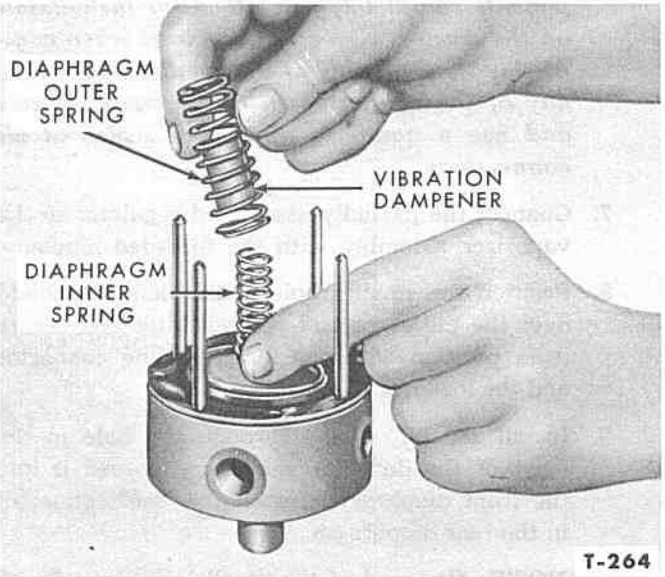

Figure 23—Installing Diaphragm Inner and Outer Springs

10. Install the air balance line after aligning the two connectors. Make certain that all connections are air tight, to prevent any possible loss of vacuum during operation of the diaphragms.

11. Install the 90° fitting in the inlet of the vaporizer assembly.

Vaporizer—Late Model:

1. Place fuel valve spring (4), Figure 20, over boss in center of vaporizer body (13). Place the fuel valve (14) on the spring making sure the short stem of valve is toward the body and that the spring is contacting the machined shoulder of the valve.

2. Install a new valve seat "O" ring (5) on the valve seat (15). Thread the valve seat into the body and tighten it securely with a 1" socket wrench.

3. Install the four Aligning Studs C161-195 in the vaporizer body as shown in Figure 22.

4. Place the fuel valve cap (6), Figure 20, on the fuel valve stem. Install a new gasket (16) on the aligning studs.

5. Position the baffle plate (7) with the recessed side down over the studs. Make certain that the fuel valve cap enters the hole in the baffle plate. Install the diaphragm (17) with the flanged disc facing up.

6. Place the diaphragm inner spring over the center of the diaphragm as shown in Figure 23. Place the dampener over the inner spring, then, place the outer spring over the dampener.

7. Install the diaphragm cover (10), Figure 20, over the aligning studs. Install four cover attach-

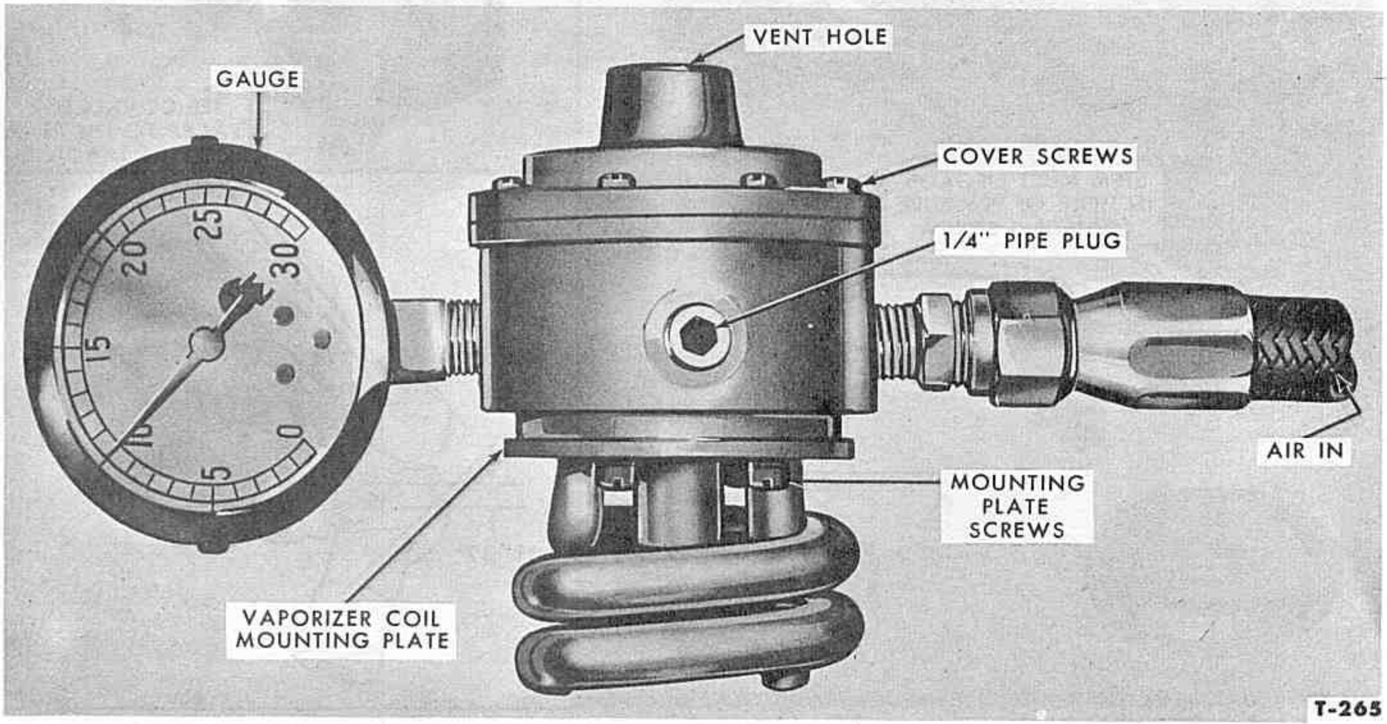

Figure 24—Checking Vaporizer for Leaks

ing screws (19) and tighten them until they seat lightly.

8. Remove the four aligning studs and install the four remaining screws. Tighten all cover attaching screws evenly and alternately.
9. Place a new "O" ring (12) on the body and two new "O" rings (2) on the coil and mounting plate (18).
10. Secure the coil and mounting plate (1) to the body with four attaching screws (11).

    NOTE: ***If the holes in the plate do not line up with those in the body, turn the plate 180° (½ turn).***
11. Connect a 0 to 30 psi gauge to one of the three vaporizer outlets. Close the remaining outlets with ¼" pipe plugs, Figure 24.
12. Connect the vaporizer inlet to a source of compressed air. Loosen the gauge connection until it leaks, then retighten and read the pressure. Gauge should register a pressure of between 9 and 11 psi and remain steady. If gauge reading creeps up, it indicates that vaporizer valve or valve seat is leaking. If leak is indicated, eliminate the leak by cleaning or replacing valve parts as necessary.
    a. Cover vent hole in diaphragm cover with liquid soap. If bubbles form at this point, the diaphragm is leaking. Replace the diaphragm and recheck for leak.
    b. Check with liquid soap for leaks around diaphragm cover. If bubbles form, replace the baffle plate gasket.
    c. Check for leaks at the pipe plugs. If bubbles form, apply pipe plug compound and tighten the plugs.
    d. Check for leaks at the vaporizer coil mounting plate. If bubbles form, replace "O" rings.

E. Vaporizer Adjustment—Early Model:

The vaporizer assembly must be adjusted for a working pressure of 10 psi (Gauge Pressure) at each overhaul and at any time the pressure adjusting screw is moved.

1. Place the assembly in a vise or suitable clamp and secure an air hose which will apply approximately 75 psi to the inlet connection, Figure 25.
2. Connect a 0 to 30 lb. pressure gauge to the outlet.

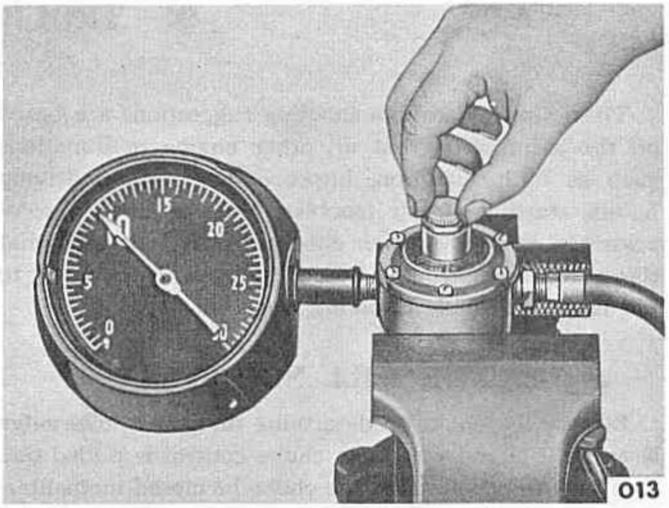

Figure 25—Vaporizer Pressure Adjustment

3. Back off the vaporizer adjusting screw until only one or two threads are holding the screw in the cover and apply air pressure to the unit.
4. Turn the pressure adjusting screw in slowly until a reading of 10 psi shows on the gauge.

    NOTE: ***To obtain an accurate gauge reading, it may be necessary to unscrew the gauge partially to bleed off some of the air. Retighten the gauge and readjust for 10 psi. If the proper reading cannot be obtained, it will be necessary to check the components of the vaporizer for correct assembly procedure.***
5. After the proper adjustment has been made, tighten the lock nut on the pressure adjusting screw. Turn off the air pressure and disconnect the gauge and air line.

F. Installation

1. Install a new "O" ring on the vaporizer body. Coat the "O" ring with a film of oil to facilitate installation of the vaporizer.
2. Position the vaporizer in the water jacket and secure with a bolt and lock washer.
3. Install the radiator upper hose.
4. Connect the flexible fuel line to the fitting on the vaporizer. Connect the metal fuel line to the carburetor and pressure regulator.
5. Fill the cooling system with coolant.

9. TROUBLE SHOOTING

The following trouble shooting suggestions are based on the assumption that all other engine malfunctions such as faulty ignition, improper lubrication, driving habits, starting circuit troubles, poor or uneven compressions, etc., have been checked. It is suggested that these sources of trouble be checked out by referring to the Engine Trouble Shooting, page 46.

ENGINE WILL NOT START

Inspect the choke to determine that the choke valve is entirely closed when the choke control is pulled out. It is very important that the choke be closed momentarily when starting either a cold or hot engine to create a partial vacuum in order to open the regulator to start the vapor flowing toward the engine. DO NOT hold the choke in a closed position while cranking the engine for more than two or three seconds. An engine "flooded" by overchoking with LP-Gas can be cleaned out by cranking it with both the choke and throttle wide open for a few engine revolutions.

A. Fuel

Make certain that the fuel being used is compatible with the corresponding atmospheric temperature. Butane, as an example, will remain in a liquid state at temperatures below 31° F. As a result, there will be no vaporizing action of the fuel at these temperatures.

B. Fuel Withdrawal Valves

If the liquid or vapor withdrawal valves are opened too fast, the integral "excess" flow valves contained in these assemblies will shut off the fuel supply from the tank. Close either withdrawal valve being used to reset the excess flow valve, and open the valve SLOWLY.

C. Regulator

The regulator must be properly adjusted as outlined on page 145 of this manual. Make certain that the fuel withdrawal valve in use is turned completely "ON" so that there is little possibility of starving the engine fuel demand.

D. Crankcase Oil

The engine oil tends to thicken after a period of continued use without oil changes. Since there are no thinning agents in LP-Fuels, the engine oil should be changed as recommended.

INSUFFICIENT ENGINE POWER

The carburetor adjustment, when properly set, should provide a smooth engine performance. If the engine does not run smoothly after carburetor adjustment has been attempted, check the following items:

A. Air Cleaner

Inspect the air intake screen on the air cleaner for a clogged condition. Clean the lower filtering mesh by flushing it in a good grade solvent and replenish the oil cup with 1.3 pints of engine oil.

B. Intake Manifold and Carburetor Connections

Check the intake manifold nuts for tightness. Check the carburetor to make sure that it is secured tightly to the manifold mounting flange. Tighten all loose nuts to the correct torque specifications.

C. Regulator Line Connections

Inspect the regulator fuel and balance line connections at the regulator and carburetor for looseness. Tighten all loose connections.

D. Regulator

Check the adjustment of the regulator in accordance with the instructions given on page 145 of this manual.

E. Ignition Timing

Check the basic ignition timing. Correct timing for all tractor engines with an LP-Gas system is 4° B.T.D.C. at 475 rpm.

F. Spark Plug Gap

Check the spark plug gap settings. The correct plug gap is .028 to .031 inch.

ENGINE HESITATES OR DIES ABOVE IDLE

Check any of the five items previously listed in the previous section, plus the following:

Fuel Filter: The fuel filter element may be obstructed to the point where fuel flow is hampered through the filter.

Clean the element or replace it with a new part if damaged.

FUEL LINE LEAKAGE

Leakage at the fuel line connections may or may not be evidenced by an icing condition at the connections. A more positive check for determining leakage is the use of a soapy water solution applied at each connection. Bubbles will form immediately when the solution is applied over any leak. The recommended procedure for checking fuel line leakage is given as follows:

1. Start the tractor engine on vapor fuel withdrawal and then close the valve so that the engine may burn off all the fuel in the lines. Turn off the ignition key.
2. Open the vapor withdrawal valve to fill the lines.
3. Start at the withdrawal valves and coat the fittings plus *approximately one half inch of line* beyond the connections. Use a brush or swab to apply the soapy solution.
4. Observe the coated areas for the appearance of soap bubbles. If a leak shows at the connections, tighten the fittings with a wrench. Recheck the connections using more solution.
5. Check all line connections and component connections throughout the system in this manner.

10. SPECIFICATIONS

LP-Gas—Carburetor

Part No.	Idle Jet Size
310289	None
B9NN-9510-A	0.175" 0.176"

Fuel Tank

Liquid Fill	24 gallons
80% Fill	19.2 gallons

11. SPECIAL TOOLS

The following special tools will assist in the disassembly, assembly and testing of the LP-Gas carburetors and vaporizers.

Tool No.	Description
C-161-193	Jet Wrench
C-161-194	Lever Gauge
C-166-51	Studs
C-161-195	Studs
▲ ▲	Pressure Gauge 0-30 lbs.

Part ONE

POWER PLANT

Chapter

VII

Cooling System

Section Page

1 Care of the Cooling System 150

2 Radiator, Hose and Pressure Cap 151

3 Water Pump 153

4 Thermostat 154

5 Fan and Generator Belt 155

6 Trouble Shooting 155

7 Specifications 157

8 Special Tools 157

The tractor cooling system is composed of the radiator, the necessary hose and a pressure cap, the water pump, a thermostat and the fan belt which drives the water pump, fan and generator. The system is of the full flow type, Figure 1, with a centrifugal pump delivering 16 gpm at 1400 engine rpm. The pump speed to engine speed ratio is 1.52:1. The thermostat controls the flow through the system maintaining the temperature at which the engine can deliver maximum power and economy.

To maintain peak efficiency, the cooling system must be kept air and water tight, and must be kept clean at all times.

Although the cooling system controls the operating temperature of the engine, other factors such as late ignition timing, poor fuel, or improper crankcase lubricant can contribute to engine overheating.

1. CARE OF THE COOLING SYSTEM

A. Draining and Flushing Cooling System

The cooling system should be drained and flushed twice yearly, usually in the spring and fall. Drain the system by opening the drain cock at the bottom of the radiator, and the drain cock on the left side of the cylinder block. Remove the radiator cap to facilitate draining. The thermostat should be removed prior to the flushing operation and installed after flushing is completed. To flush the cooling system, disconnect the radiator upper and lower hose and remove the upper hose. Flush the engine and radiator separately, first in the direction of normal flow, then in a reverse direction. Use a flushing gun made especially for this purpose. A reversed direction of water flow will loosen sediment more quickly than in the normal direction of coolant flow. If a pressure type flushing system is used, be sure the cylinder head bolts are properly tightened to prevent water leaks into the cylinders. If the system is excessively clogged or contaminated, use Ford Radiator Cleaner, Part No. 81A-1844N, as recommended on the container. Close all drain cocks and install hoses, if removed. Remove all trash from between the radiator fins with compressed air.

B. Filling the Cooling System

Before filling the cooling system, be sure that it has been checked for leaks, and that the thermostat and the temperature gauge are working properly. Fill the system with the recommended coolant, depending on the prevailing temperatures and water conditions in your area.

To prevent the accumulation of rust or scale in the cooling system, use Rust Inhibitor, Part No. 8N-19546. It is a good practice to use rust inhibitor every time the cooling system is drained, and especially after it has been flushed. Rust inhibitor guards against additional rust or corrosion but does not remove or dissolve rust. It is a preventive only, and not a cleaner.

If the tractor is operated in a locality where there is lime or alkali in the water, rain or distilled water should be used for a coolant. Deposits caused by lime or alkali water quickly build up in coolant passages in the engine

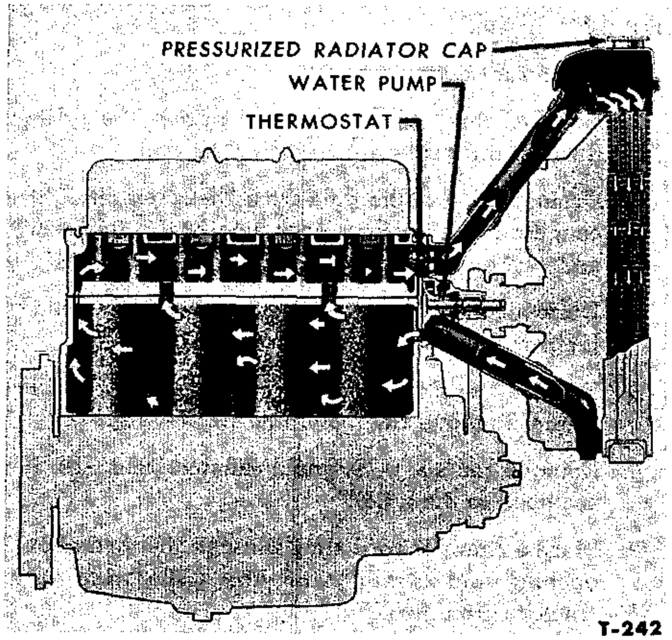

Figure 1—Cooling System—Sectional View

or radiator and, in time, will cause engine overheating that may eventually result in a cracked cylinder block or head. If water containing lime or alkali must be used, add a water softener purchased from a reputable company, in the amount shown on the container.

C. Cooling System Protection—Anti-freeze

If the temperature falls below the freezing point of 32°F., anti-freeze must be added to the cooling system. Alcohol is not recommended as protection against freezing because it starts to boil at about 170°F., and during heavy-duty operation, the tractor may operate at temperatures above this figure. Therefore, permanent type anti-freeze is recommended. Before using anti-freeze in the system, be sure all water connections and cylinder head bolts are tight. If anti-freeze is unnecessary in the area where the tractor is operated, the cooling system should be treated with a rust and corrosion inhibitor as previously recommended.

IMPORTANT: ***Calcium chloride must never be used because it will corrode and clog the cooling system in a short time.***

The following charts show the amount of anti-freeze required to protect the cooling system from freezing. The capacity of the system is 15 qts. for all tractors.

United States Anti-Freeze Chart

Temperature	Ethylene Glycol
20°F.	6 pts.
10°F.	8 pts.
0°F.	11 pts.
—10°F.	12 pts.
—20°F.	14 pts.
—30°F.	15 pts.

British Imperial Anti-Freeze Chart

Temperature	Ethylene Glycol
20°F.	5¼ pts.
10°F.	7 pts.
0°F.	9¾ pts.
—10°F.	10¼ pts.
—20°F.	12 pts.
—30°F.	12½ pts.

2. RADIATOR, HOSE AND PRESSURE CAP

The pressure type cooling system in the Ford Tractor maintains a regulated pressure of 3½ to 4½ lbs. during operation. With a pressure system, the coolant boils at a higher temperature than normally. It is important, therefore, that all elements of the cooling system are operating properly at all times. A complete radiator assembly is shown in Figure 2.

A. Radiator Pressure Cap

The radiator is sealed with a pressure cap. Inside the cap are two valves. The larger valve is the pressure valve, and the smaller one is the vacuum valve. When the coolant boils, pressure in the system forces the pressure valve open at 3.5-4.5 psi, allowing the coolant to escape through the overflow pipe, Figure 2. When pressure in the system becomes lower than atmospheric pressure, the vacuum valve opens at 0—.25 psi until the pressure in the system and the atmospheric pressures are approximately equalized. The cap must provide an absolutely air-tight seal at all times for the system to operate properly. If defective, the cap should be replaced.

B. Radiator Hoses

Radiator hoses should be replaced whenever they become cracked or soft. To replace the hoses, drain the radiator then loosen the clamp bolt at each end of the hoses. Slide the hose off the radiator connection and the cylinder head water outlet connection (upper hose) or the water pump connection (lower hose). To install new hoses, position the clamp on each end of the new hose, slide the hose on the connections, and tighten the clamp bolts securely. Fill the radiator with coolant, then run the engine for several minutes and check each hose and connections for leaks.

C. Radiator Removal

All Except Series 1801:

1. Drain the radiator. Remove the radiator cap to assist draining action. Remove the grille and hood.
2. Loosen the radiator upper and lower hose clamps and slide the hose off the radiator upper connection.
3. Remove the lower hose, then remove the two nuts and washers from the bottom of the radiator and lift the radiator from the tractor.

NOTE: *The fan shroud, Figure 2, is attached to the radiator. It will be necessary to remove the shroud if the radiator is to be reconditioned.*

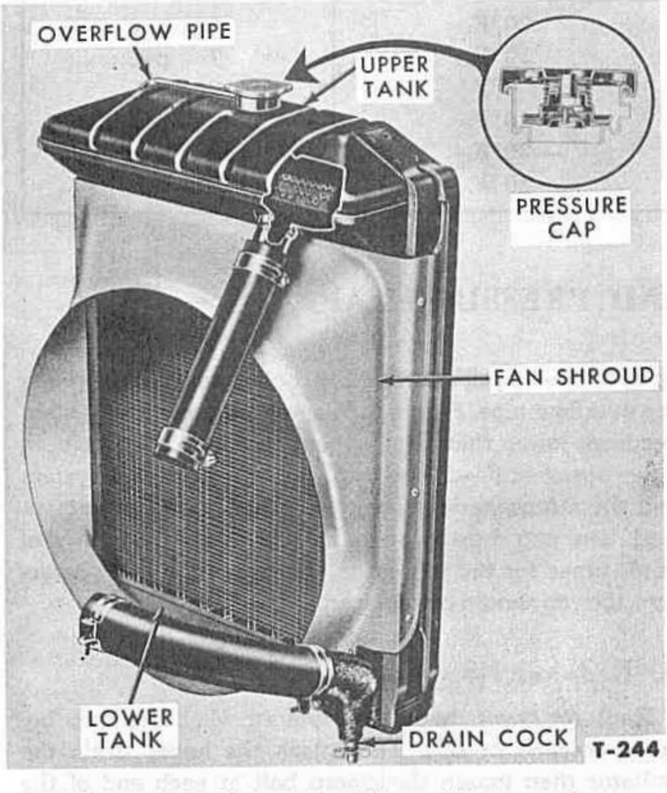

Figure 2—Radiator Assembly and Pressure Cap

Series 1801 Tractors:

1. Drain the cooling system.
2. Remove the four screws that attach the grille door to the grille and remove the door.
3. Drain the hydraulic fluid from the reservoir. Disconnect the hose from each side of the reservoir and cap all openings to prevent entry of dirt.
4. Disconnect the headlamp wires from the headlamp wiring harness.
5. Remove the six bolts that attach the grille to the frame. Remove the medallion from the grille.
6. Remove the six bolts and insulators that attach the hood to the grille.
7. Place a chain or rope sling through the medallion opening and carefully lift the grille from the tractor with a hoist.
8. Disconnect the two oil cooler lines from the radiator lower tank and cap all openings. Disconnect the upper and lower hoses from the radiator. Remove the two attaching nuts and flatwashers from the lower end of the radiator. Lift the radiator and fan shroud from the tractor as an assembly.

D. Radiator Installation

All Except Series 1801:

1. Carefully position the radiator in the tractor. Be sure the insulation pads are in place around each bolt hole in the bottom of the radiator.
2. Secure the radiator with the two attaching nuts and flatwashers.
3. Slide the upper hose on the radiator connection and tighten the hose clamp securely. Install the lower hose and tighten the clamps securely.
4. Fill the cooling system with the proper coolant, then run the engine and check the system for leaks.
5. Install the hood and grille.

Series 1801 Tractors:

1. Position the radiator and shroud assembly in place on the frame and install the two attaching flatwashers and nuts. Connect the upper and lower hoses to the radiator.
2. Connect the two oil cooler lines to the radiator lower tank.

3. Carefully lower the grille into position on the tractor and install the six attaching bolts.
4. Connect the hose to each side of the reservoir. Install the medallion in the grille.
5. Connect the headlamps to the headlamp wiring harness. Install the grille door in the grille.
6. Secure the hood to the grille with the six rubber insulators and bolts.
7. Fill the cooling system with the proper coolant.
8. Fill the hydraulic reservoir to the proper level with M2C41 oil.
9. Start the engine and check for leaks.

3. WATER PUMP

The water pump used on the Ford Tractors requires no lubrication. The bearing used in the pump is integral with the pump shaft.

A repair kit is available for servicing the pump. Figure 3 shows the pump disassembled.

A. Removal

1. Drain the radiator. Loosen the hose clamp at the pump end of the hose, and pull the hose off the casting.
2. Remove the fan belt adjustment strap bolt, then remove the belt.
3. Remove the fan attaching bolts and lockwashers then remove the fan.
4. Remove the water pump attaching bolts and lockwashers. Remove the pump and gasket.

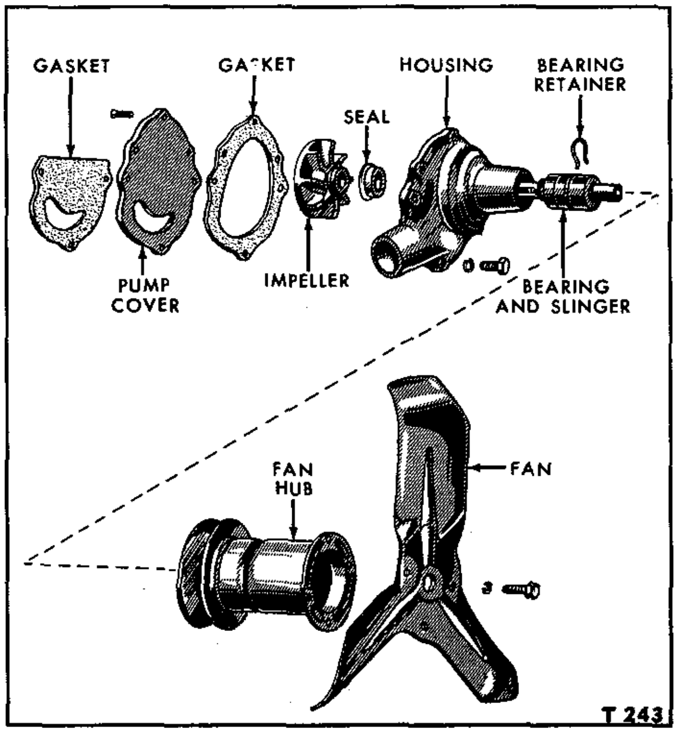

Figure 3—Water Pump Disassembled

B. Disassembly

1. Remove the pump cover and cover gasket, Figure 3.
2. Remove the pulley from the shaft with Remover 8501-DD-2.
3. Remove the bearing retainer.
4. Press the shaft and bearing assembly out of the impeller and pump body, as shown in Figure 4. Use a suitable adapter or plate to hold the pump body in the position shown.
5. Remove the seal from the pump body by driving it toward the impeller end of the pump.

C. Assembly

1. Press the shaft and bearing assembly into the housing as shown in Figure 5. Position the retaining clip groove so that it is aligned with the groove in the housing. Install the bearing retainer, Figure 3, on the bearing.

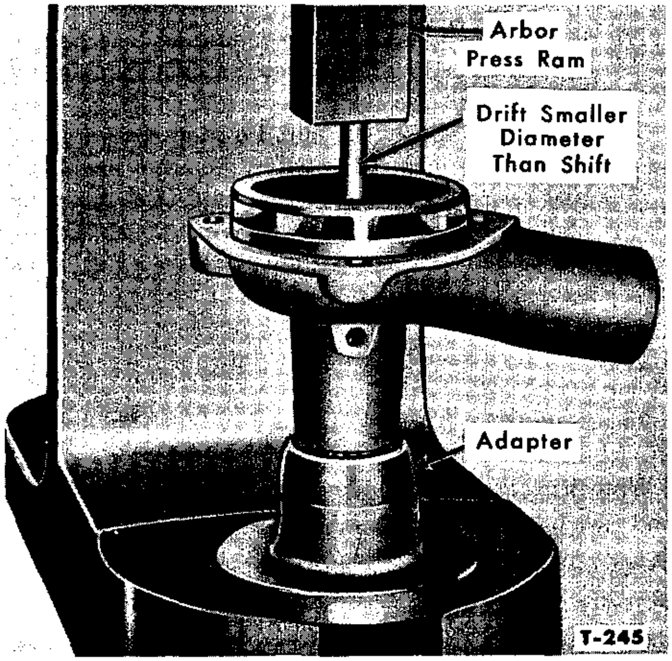

Figure 4—Removing Water Pump Shaft and Bearing

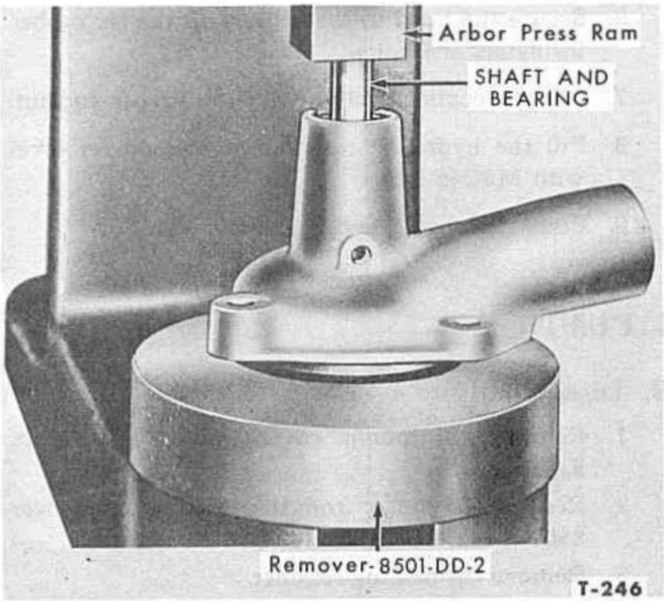

Figure 5—Installing Water Pump Shaft and Bearing

2. Press the seal into the housing as shown in Figure 6, using a suitable adapter to press against the shoulder of the seal.

3. Press the impeller on the shaft. When the rear face is nearly flush with the housing, check the clearance between the rear of the impeller and the face of the housing. Use a straight edge and feeler gauge. The clearance should be 0.015 to 0.025 inch. This is necessary to prevent the impeller from rubbing on the pump cover during operation.

4. Place the pulley hub fan mounting face on the base of an arbor press. Place the shaft (previously pressed into the pump body and impeller) into the pulley end of the hub. Position a short piece of ⅜ or ½ inch rod between the arbor press ram and the impeller end of the shaft, then press the shaft into the hub. Be careful not to push against the impeller, since this might move it out of its proper position on the shaft.

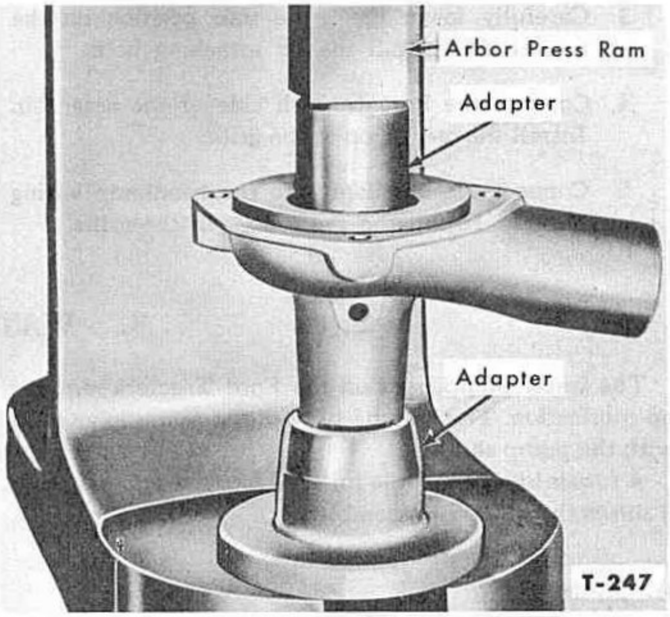

Figure 6—Installing Seal in Housing

NOTE: ***When correctly installed, the pulley hub should just clear the shaft bearing, without any bind.***

5. Install the pump cover and a new gasket, and secure with the three bolts.

D. Installation

1. Position a new gasket on the pump body, then attach the pump to the cylinder block with the three bolts and lockwashers. Tighten the bolts to 10-15 lbs. torque.

2. Connect the hose, close the radiator drain cock, and fill the radiator with coolant suitable for the prevailing temperature.

3. Install the fan and generator belt and adjust the belt tension to ¼″ deflection under 15-20 lbs. pressure, Figure 7.

4. THERMOSTAT

The thermostat used in the Ford Tractor is a spring and cartridge type, and is mounted in the cylinder head water outlet elbow. The thermostat regulates the temperature in the cooling system by controlling the flow of coolant through the system. When the engine is cold, the thermostat is closed and the coolant does not circulate through the radiator. As the engine warms up, the thermostat gradually opens, and is fully open at normal operating temperature.

The thermostat on gasoline or LP-Gas models should start to open at 157° to 162°F. and be fully open at 177° to 182°F. The thermostat on four diesel models start to open at 178° to 182°F. and be fully open at 202°F.

A. Removal

1. Drain the cooling system.
2. Disconnect the radiator upper hose at the cylinder head water outlet elbow.
3. Remove the bolts that attach the water outlet elbow to the cylinder head, and remove the elbow, thermostat and gasket.

B. Inspection

1. Immerse the thermostat in a pan of water along with a suitable thermometer.
2. Raise the temperature of the water to the range in which the thermostat operates.
3. If the thermostat does not open within the limits given, it should be replaced.

C. Installation

1. Place the thermostat in the cylinder head with the metal spiral facing toward the engine.

   NOTE: ***It is extremely important that the thermostat be positioned correctly in the cylinder head. If the thermostat is improperly positioned, it can cause a retarded flow of the coolant and result in overheating.***

2. Install a new outlet elbow gasket. Position the outlet elbow against the cylinder head and install the attaching bolts.
3. Torque the outlet elbow bolts to 8-10 ft. lbs.
4. Connect the radiator hose and close the drain cocks. Fill the cooling system and run the engine until it reaches normal operating temperature. Then, check for leaks.

5. FAN AND GENERATOR BELT

The water pump is driven by the same belt that drives the fan and generator. Any loooseness in the belt tension may result in overheating. Overtightening the belt, on the other hand, may result in excessive wear on the generator armature bearings and water pump bearing, as well as premature wear of the fan belt itself. Check the belt periodically for proper tightness.

A. Fan Belt Adjustment

1. Adjust the belt tension by loosening the two generator pivot bolts and the belt tension adjusting bolt.
2. Move the generator either away or toward the engine, until ¼″ belt deflection is obtained under 15-20 lbs. pressure, Figure 7.

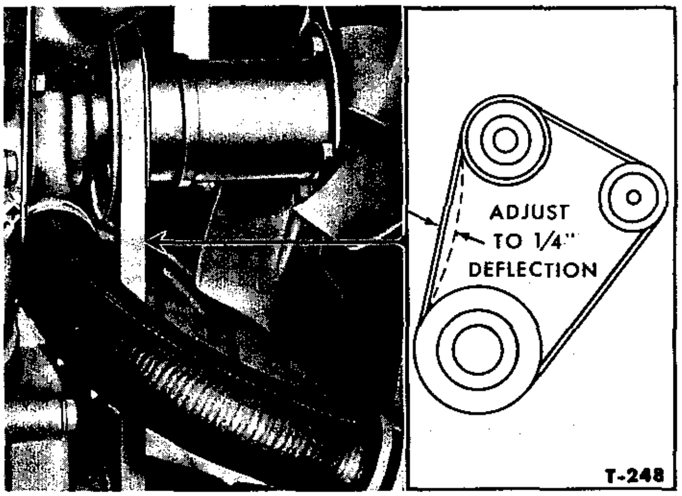

Figure 7—Fan Belt Adjustment

B. Fan Replacement

1. Remove the four bolts and lock nuts from the fan blades and remove the fan from the hub.
2. Place a new fan in position on the hub and install the four bolts and lock washers. Tighten the bolts evenly and alternately.

6. TROUBLE SHOOTING

The coolant flow is thermostatically controlled to regulate engine operating temperature and provide for a short engine warm-up period. The system will fail to cool the engine sufficiently when the supply of coolant is low, circulation is stopped due to blocked passages, loose fan belt, or if the thermostat is stuck closed. Deposits of lime and rust can prevent heat transfer through the water jacket walls, and also cause the engine to overheat.

A. Engine Overheats

The engine will overheat when there is insufficient transfer of heat to the coolant and to the air passing over the engine.

Preliminary Instructions: The various factors that control the cooling of the engine are designed to provide a liberal margin of safety. In most cases, correction or adjustment of these controls will re-establish adequate cooling.

1. Heavy work requires operation through whatever transmission gear ratio is required to keep the engine from lugging. By shifting to a lower gear, the engine speed and consequently the fan speed and water circulation are increased, thus providing adequate cooling.

2. To prevent loss of coolant due to evaporation, a permanent type anti-freeze should be used. This raises the boiling point of the coolant and eliminates overheating attributable to loss of coolant.

Procedure: Check for leakage and operation of parts as outlined below:

1. Fill the cooling system and operate the engine at idle speed. Inspect all hose and hose connections for leakage. Tighten connections or replace hose as required. Inspect the radiator cap for tightness and note the condition of the gasket. If leakage is observed at the cylinder head gasket, replace the gasket (including remove carbon). Inspect the radiator for leakage, and repair or replace if required. Rust spots or wet spots on the radiator core are an indication of radiator leakage even though there is no dripping.

2. Adjust or replace the fan belt if required.

3. Inspect the exhaust pipe, muffler, and tail pipe for evidence of dents, kinks, collapse, or restrictions of any kind.

4. If the air flow through the radiator is restricted (insects, leaves, grease, dirt, etc.), clean the fins and air passages.

5. Time the ignition and check spark advance.

6. Inspect the radiator hose. Replace any hose that has become soft or collapsed.

7. Remove the thermostat and place it in hot water. Thermostats should operate according to the temperatures given in specifications. Replace a faulty thermostat.

8. Use Cooling System Cleaner, Part No. 81A-18442, according to the directions on the container.

9. Drain the oil from the engine oil pan, and check for water in the oil. If water is present in the oil, remove the spark plugs and check for water at the plug holes. With the engine cold, fill the radiator to the top. Remove the belt so the water pump will not operate. Run the engine at fast idle for 60 seconds. If water runs out of the radiator filler pipe or overflow, or if bubbles come to the surface of the water in the radiator, leakage exists between one or more of the cylinders and the cooling system.

10. If leakage is evident, check the cylinder head bolts with a torque wrench. If the bolts do not show signs of looseness, remove the cylinder head and inspect for a faulty gasket or head. Examine the cylinder head in the vicinity of the valve ports for cracks. Replace the cylinder head gasket or make necessary corrections in case of a cracked block. When installing the head, tighten the bolts to 65-70 ft. lbs. torque on a gasoline or LP-Gas engine or 100-105 ft. lbs. on a diesel engine.

Additional Possible Causes: Deposits on water jacket walls cause overheating by preventing the transfer of combustion chamber heat to the coolant.

1. If the engine continues to overheat, remove the cylinder head and inspect the water openings in the cylinder head and cylinder block for excessive lime deposits. If excessive lime deposits are present, the cylinder block and head must be replaced as flushing will not remove lime deposits.

NOTE: *Excessive deposits of lime are the result of using hard water having a high mineral content in the cooling system. Use soft water.*

B. Engine Fails to Reach Normal Operating Temperature

This symptom is caused by a leaking thermostat or pressure cap. If the temperature gauge is incorrect, it may lead to the belief that the engine fails to reach normal temperature.

Preliminary Instructions: With the ignition "OFF," the temperature gauge should read COLD. Turn the ignition "ON." If the gauge now reads COLD, proceed with the next paragraph.

Procedure: Start the engine and allow it to idle. Cover the front of the radiator core until the engine temperature is at least normal. If the gauge still reads COLD, the sending unit or the gauge is at fault.

1. If the gauge is not at fault, remove and test the thermostat.
2. If the thermostat is in good condition but the engine still fails to reach operating temperature or fails to heat in reasonable time, remove and test the condition of the radiator pressure cap. Replace the cap if it does not operate properly.

7. SPECIFICATIONS

Radiator

Models	Free Flow When Full	Maximum Internal Pressure	System Capacity	Pressure Cap	
				Relief Valve Opens	Pressure Valve Opens
All	19½ gpm	14 psi	15 qts.	.5-1.0 psi	3½-4½ psi

Water Pump Impeller

Models	Rear Plate Impeller Clearance (Inches)	Flow gpm	Belt Deflection (Inches)
All	0.015-0.025	16 at 1400 rpm	¼ @ 15 lbs.

Thermostat

Models	Type	Temperature	Full Open
All Except Diesel	Bi-metal cartridge	157°-162° F.	177°-182° F.
Diesel Only	Bi-metal cartridge	178°-182° F.	202° F.

8. SPECIAL TOOLS

The following tools will assist in the disassembly and assembly of a water pump:

Tool No.	Description
FT 8550	Adaptor Water Pump-Slinger Installing
8501-DD-2	Remover—Water Pump Pulley

Part TWO

CLUTCH, TRANSMISSIONS, REAR AXLE and POWER TAKE-OFF

Chapter

I

Clutch

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2 Double Clutch 161

3 Clutch Release Shaft Bushings 165

4 Clutch Pedal Bushing 165

5 Clutch Pedal Adjustment 165

6 Trouble Shooting 166

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1. SINGLE CLUTCH

The regular single ten inch clutch assembly currently used in Ford Tractors is the single plate, dry disc type shown in Figure 1. Some tractor models prior to 1958 utilized a regular single nine inch clutch.

A ten inch heavy duty type clutch is used in tractors where heavier than normal loads are encountered. The material in the heavy duty clutch disc facings is more resistant to higher operating temperatures. These facings have approximately one-third more material than the regular single clutch facings and provide an increased pressure plate contact area for greater load carrying ability.

When the clutch pedal is in the engaged position, the clutch disc facings are clamped between the friction surface of the engine flywheel and the face of the clutch pressure plate, thereby connecting engine power to the transmission. Depressing the clutch pedal actuates the clutch release shaft fork which moves the clutch release bearing against the clutch fingers. This, in turn, moves the pressure plate away from the clutch disc. Since the disc is splined to the transmission input shaft, the clutch disc and transmission input shaft will stop when the clutch is disengaged, thereby disconnecting engine power from the transmission.

The service procedures for the regular single nine and ten inch clutch and the heavy duty clutch are very similar. Therefore, the following information will apply to the heavy duty clutch and any differences will be noted in their appropriate places.

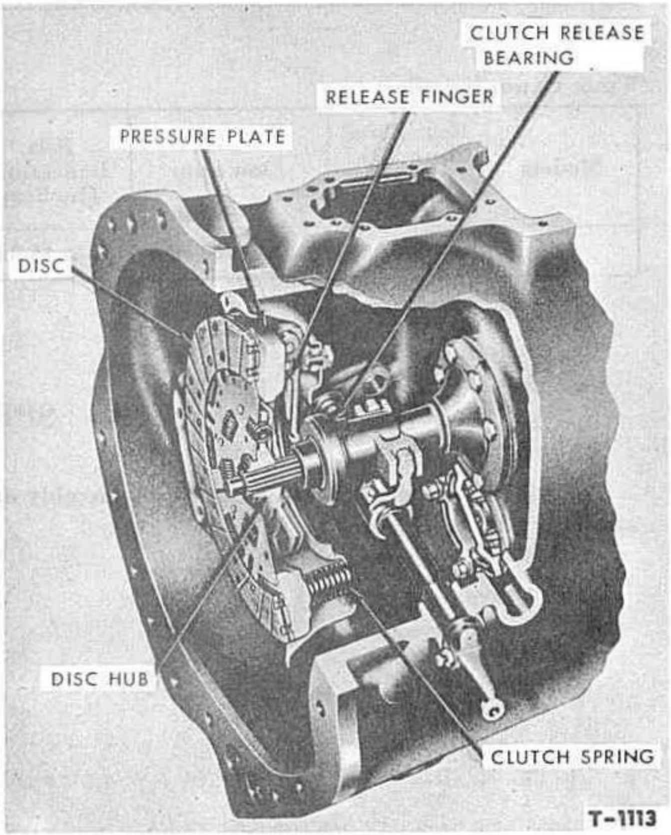

Figure 1—Single Plate Clutch—Sectional View

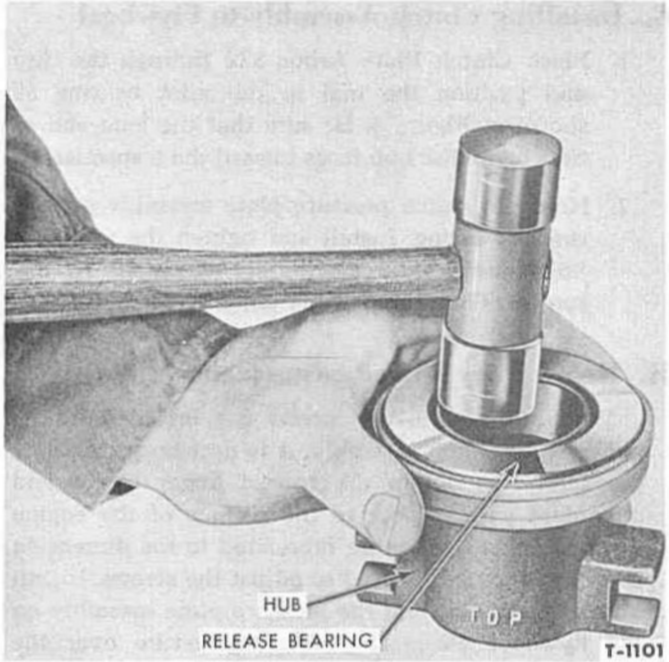

Figure 2—Removing Clutch Release Bearing

A. Removal

1. Separate the transmission from the engine as outlined on page 168.
2. Loosen the six clutch cover to flywheel bolts evenly to avoid springing the cover. Remove the bolts and lock washers while holding the pressure plate and clutch.

   CAUTION: ***Hold the pressure plate and clutch to prevent dropping it after the last bolt is removed.***

3. Disconnect the clutch release bearing spring or springs and remove the hub and release bearing assembly.

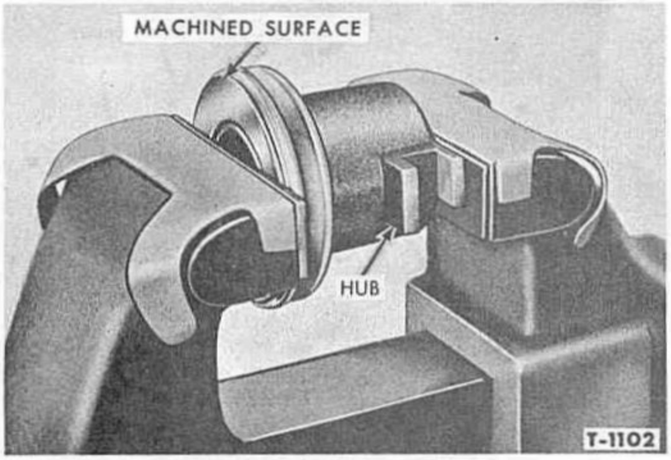

Figure 3—Installing Clutch Release Bearing

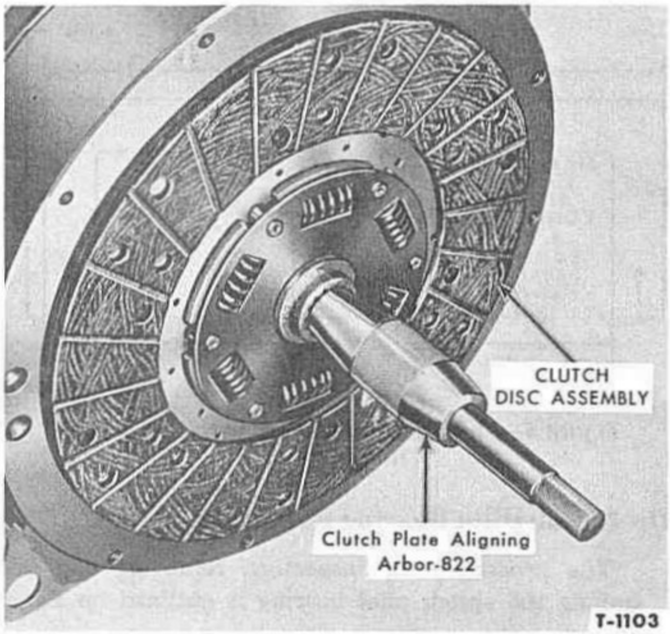

Figure 4—Installing Clutch Disc

B. Inspection

1. Examine the clutch disc facings for evidence of oil, wear or loose rivets. Replace the facings if they are oil soaked. Facings should be replaced if they are worn to where the rivet heads are less than $\frac{1}{64}''$ from the facings or if the rivets are loose.
2. The release bearing is prelubricated and should not be cleaned in solvent. Check the bearings for free movement on the hub by pressing on the front face of the bearing as it is rotated. If bearing runs rough or has noticeable side movement, replace it. Remove release bearing from hub using a soft faced hammer as shown in Figure 2. Inspect bearing to determine if it has been turning on the hub. If score marks are present on the hub, replace the bearing and the hub.
3. If the pressure plate is scored, heat checked or warped, install a new clutch pressure plate assembly.

C. Release Bearing Replacement

A new release bearing can be installed on the hub by using a vise as shown in Figure 3. Be sure that the bearing is properly aligned before pressing it on the hub.

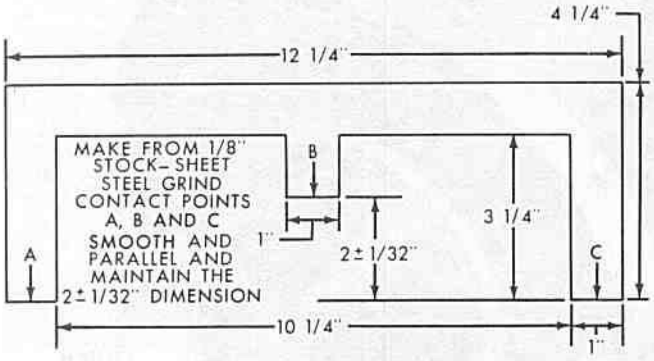
4 1/4"
12 1/4"
MAKE FROM 1/8" STOCK-SHEET STEEL GRIND CONTACT POINTS A, B AND C SMOOTH AND PARALLEL AND MAINTAIN THE 2± 1/32" DIMENSION
B
3 1/4"
1"
A
2± 1/32"
C
10 1/4"
1"
T-1104

Figure 5—Diagram for Fabricating Clutch Finger Height Tool

D. Clutch Pilot Bearing Replacement

The procedure for inspecting, removing and installing the clutch pilot bearing is outlined on Page 36.

E. Replacing Heavy Duty Clutch Disc Facings

1. Using a drill slightly larger than the diameter of the rivet heads, remove the heads of the twelve rivets that secure the cushioning springs and facing assembly (pressure plate side) to the disc assembly and separate the assemblies.

2. Remove the cushioning springs from the facing by using a riveting machine or a drill slightly larger than the peened end of the brass rivets. Mark the facing side of each spring to permit correct spring positioning on a new facing. In the same manner, separate the facing from the disc assembly.

   IMPORTANT: ***When drilling rivets, be careful not to elongate the rivet holes in the disc and cushioning springs.***

3. Using a suitable riveting tool, rivet a new facing to the flat side of the disc assembly. Then rivet the cushioning springs to a new clutch facing. Rivet the disc assembly to the spring and facing assembly using twelve steel rivets. Be sure that all rivets are properly seated and that there are no burrs on the heads.

F. Replacing Facings on a Regular Single Clutch

New facings can be installed on the regular 10 inch clutch disc in a similar manner. There are no cushioning springs in this assembly and both facings are riveted directly to the disc assembly.

G. Installing Clutch Assembly to Flywheel

1. Place Clutch Plate Arbor 822 through the disc and position the tool in the pilot bearing as shown in Figure 4. Be sure that the long end of the clutch disc hub faces toward the transmission.

2. Hold the clutch pressure plate assembly against the disc facing. Install and tighten the retaining bolts evenly and alternately to 12-16 ft. lbs. torque. Then remove the clutch pilot tool.

H. Heavy Duty Finger Adjustment

When new adjusting screws are installed in the heavy duty clutch assembly, it is necessary to adjust the screws to obtain the correct finger height and alignment with respect to the surface of the engine flywheel. A height fixture fabricated to the dimension shown in Figure 5 is used to adjust the screws. Install a new clutch disc and the pressure plate assembly on the flywheel. Place the adjusting fixture over the pressure plate assembly so that the fixture legs rest on the flywheel surface, as shown in Figure 6. Adjust each screw until they just contact the offset on the fixture. After establishing the correct adjustment, stake the screws firmly in position.

NOTE: ***The adjusting screws on new heavy duty pressure plate assemblies are set and staked and do not require further adjustment.***

If the fingers on the single standard clutch are excessively worn and more than 0.030" out of plane, the complete clutch pressure plate assembly must be replaced.

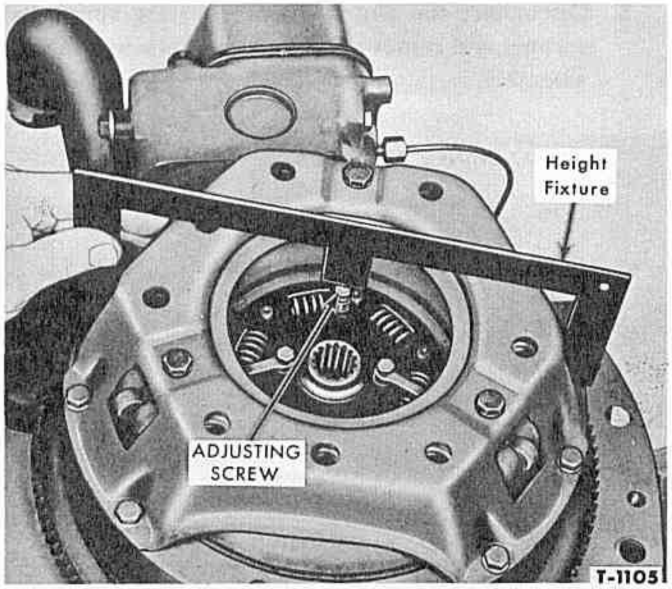

Figure 6—Adjusting Clutch Finger Height

2. DOUBLE CLUTCH

The double clutch used in Ford Tractors is the double pressure plate, dry disc type shown in Figure 7. The clutch assembly provides a means of connecting or disconnecting engine power to or from the transmission and to or from the P.T.O. input shaft. The front clutch of the assembly transmits engine power to the transmission and the rear clutch transmits power to the P.T.O. drive. Pressure plates are located on each side of the center drive plate which is secured to the flywheel by lock washers and bolts.

The pressure plates are actuated by depressing the clutch pedal the required distances, as illustrated in Figure 8. Since the adjusting screws of the transmission pressure plate release fingers are set approximately three-quarters of an inch higher than the adjusting screws in the P.T.O. pressure plate release fingers, the transmission clutch is disengaged when the clutch pedal is pushed about half way down. This much pedal action moves the clutch release bearing against the transmission clutch finger adjusting screws which in turn moves the transmission pressure plate away from the clutch disc. With the pedal in this position, engine power is disconnected from the transmission; however, the P.T.O. clutch is still engaged and the P.T.O. will continue to operate. When the clutch pedal is pushed all the way down, the clutch release bearing contacts the P.T.O. pressure plate release fingers causing the plate to move away from the P.T.O. disc. Engine power is then disconnected from the P.T.O. input shaft.

When the clutch pedal is in the engaged position, the coil springs in the clutch assembly exert sufficient pressure against the pressure plates to lock the transmission and P.T.O. discs firmly to the center drive plate. This causes both discs to turn with the engine flywheel and transmit power to the transmission and P.T.O.

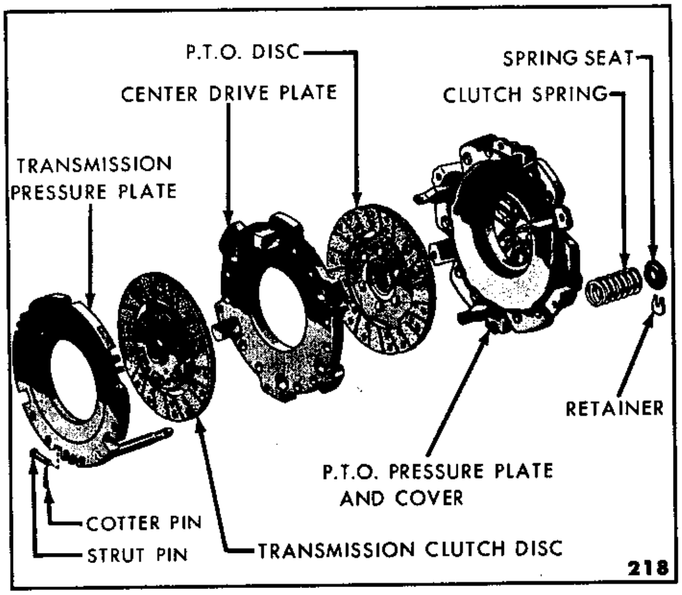

Figure 7—Double Clutch—Disassembled

A. Removal

1. Separate the transmission from the engine as outlined in "Transmission Removal and Installation."
2. Scribe alignment marks on the clutch center drive plate and engine flywheel so that the clutch assembly can be reinstalled in the same relative position.
3. Hold the clutch assembly and remove the six clutch to flywheel bolts and lock washers.

   CAUTION: ***Hold the pressure plate and clutch to prevent dropping it after the last bolt is removed.***

B. Disassembly

1. Scribe alignment marks on the transmission pressure plate, center drive plate and P.T.O. pressure plate so that they can be reassembled in the same relative position.
2. Use Valve Spring Compressor 6513-EE to compress clutch pressure plate springs, Figure 11. Remove the retainers with a punch and hammer, then remove the spring seats and springs.
3. Remove the six bolts that retain the P.T.O. pressure plate and cover assembly to the center drive plate; also the three pins and cotter pins that retain the cover assembly to the transmission pressure plate. Then, remove the cover assembly from the center drive plate.
4. Remove, in order, the P.T.O. clutch disc assembly, the center drive plate and the transmission clutch disc assembly from the transmission pressure plate.

C. Inspection

1. Examine the pressure plates and center drive plate for score marks and signs of overheating. If plates are warped, scored or damaged. they should be replaced. Also, check the transmission pressure plate spring rods for damage and replace plate if necessary.

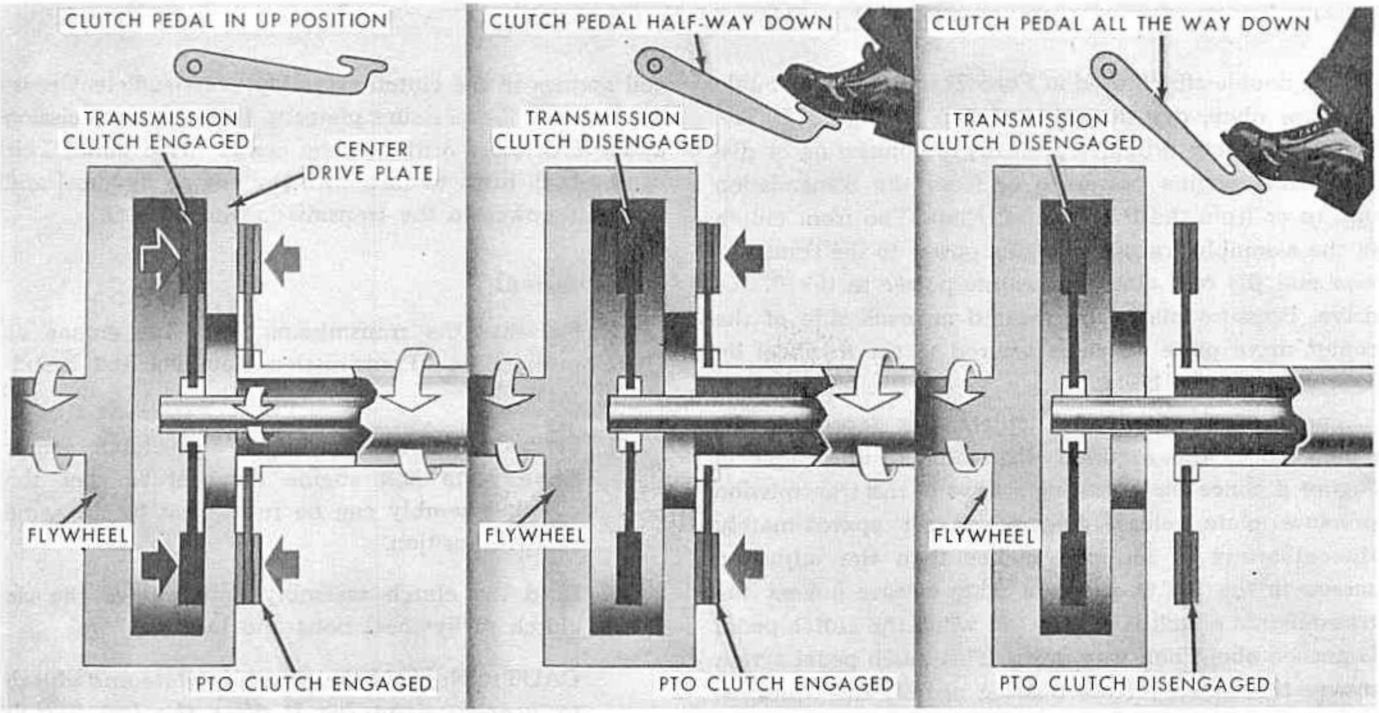
CLUTCH PEDAL IN UP POSITION
TRANSMISSION CLUTCH ENGAGED
CENTER DRIVE PLATE
FLYWHEEL
PTO CLUTCH ENGAGED
CLUTCH PEDAL HALF-WAY DOWN
TRANSMISSION CLUTCH DISENGAGED
FLYWHEEL
PTO CLUTCH ENGAGED
CLUTCH PEDAL ALL THE WAY DOWN
TRANSMISSION CLUTCH DISENGAGED
FLYWHEEL
PTO CLUTCH DISENGAGED

Figure 8—Power Flow Through Double Clutch

2. Discard all of the clutch spring retainers.
3. Inspect the clutch pilot bearing. The procedure for inspecting, removing and installing the clutch pilot bearing is detailed on page 36.
4. Discard any clutch springs that do not meet the specifications. See Specifications on Page 166. A method for checking springs is outlined on Page 15.
5. New facings can be installed on the disc assemblies as outlined in the Single Clutch Section.
6. Inspect the release bearing as outlined in "Inspection for the Single Clutch."
7. Inspect clutch finger adjusting screws. If crowns on heads of screws have worn flat and thin, install new screws.

D. Assembly

The Double Clutch Adjusting Fixture NDA-7502 has been developed to facilitate proper servicing of the double clutch. No attempt should be made to assemble or adjust the clutch unless this tool is used.

1. Install the transmission pressure plate assembly on Base Plate NDA-7502-7. Place the transmission clutch disc in position over Spindle NDA-7502-5. Be sure that the side with the springs flush with the disc is installed toward the transmission end of the clutch as shown in Figure 9.

NOTE: ***Each service plate assembly is marked with a paint mark on the heavy side. To retain proper clutch balance whenever a new plate is installed, position new plate approximately 120° apart from marks on the other plates.***

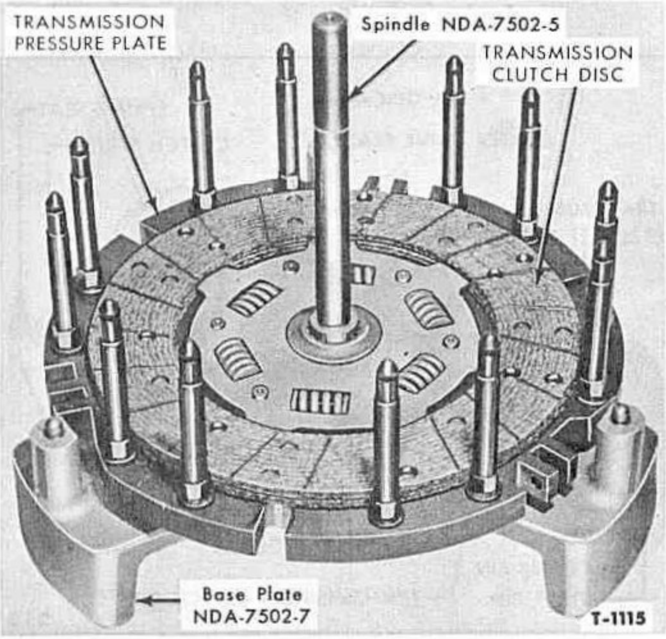

Figure 9—Assembling Double Clutch on Fixture

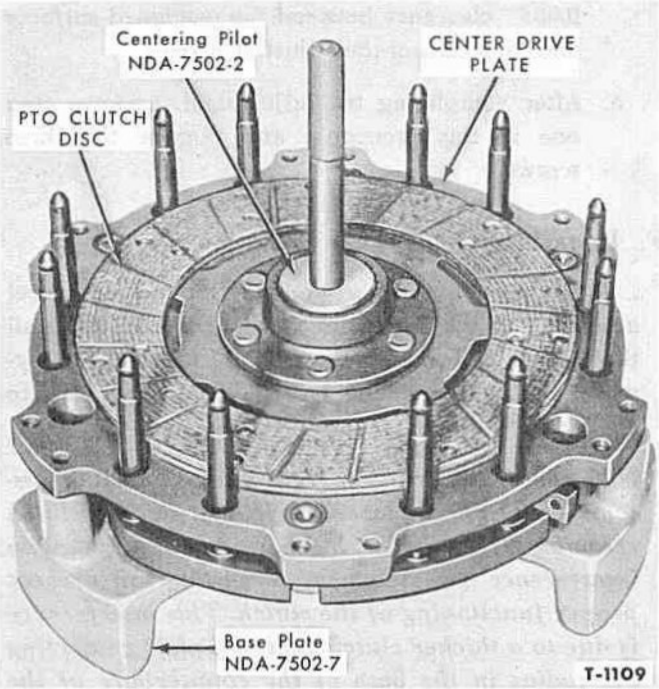

Figure 10—Center Drive Plate and P.T.O. Disc Installed

2. Install the center drive plate, according to the alignment marks at the time of disassembly, with the clutch drive dogs meshed in the transmission pressure plate.

3. Install the P.T.O. clutch disc with the hub facing up, as shown in Figure 10.

4. Install disc Centering Pilot NDA 7502-2 in the P.T.O. disc with taper on pilot facing down.

5. Install the P.T.O. pressure plate and cover assembly over the PT.O. disc.

6. If necessary, lift up the transmission drive plate to align the strut pin holes Then install the pins and new cotter pins to secure the struts. Install the six bolts that retain the P.T.O. pressure plate and cover to the center drive plate and tighten bolts to 12-15 ft. lbs. torque.

7. Install all the clutch pressure plate springs, spring seats and retainers, using the Valve Spring Compressor 6513-EE as shown in Figure 11.

   IMPORTANT: ***Never install used clutch spring retainers as clutch failure may result. Install new retainers with the closed end of the retainer toward the center of clutch. Pinch open ends with small nose pliers. Then remove compressor tool.***

E. Double Clutch Adjustment at Assembly

1. With assembled clutch in fixture, place Gauging Block NDA-7502-1 over center pilot, with flat surface of tool resting on clutch finger adjusting screws. Install a flat washer and nut, turn nut clockwise and compress clutch fingers until the three Spacers NDA-7502-3 can be positioned.

2. The narrow spacer block marked TOP must be placed between the center drive plate and the machined surface of the P.T.O. pressure plate. The lower spacer block must be placed between the machined surface of the transmission plate and the center drive plate. The spacers must be positioned 120° apart and inserted until the blocks touch the clutch discs, as shown in Figure 12.

3. Before removing Gauging Block NDA-7502-1, be sure that the disc centering tool bottoms on the shoulder on the pilot for the transmission clutch discs.

4. Remove gauging tool and reinstall tool in the inverted position, as shown in Figure 13. The

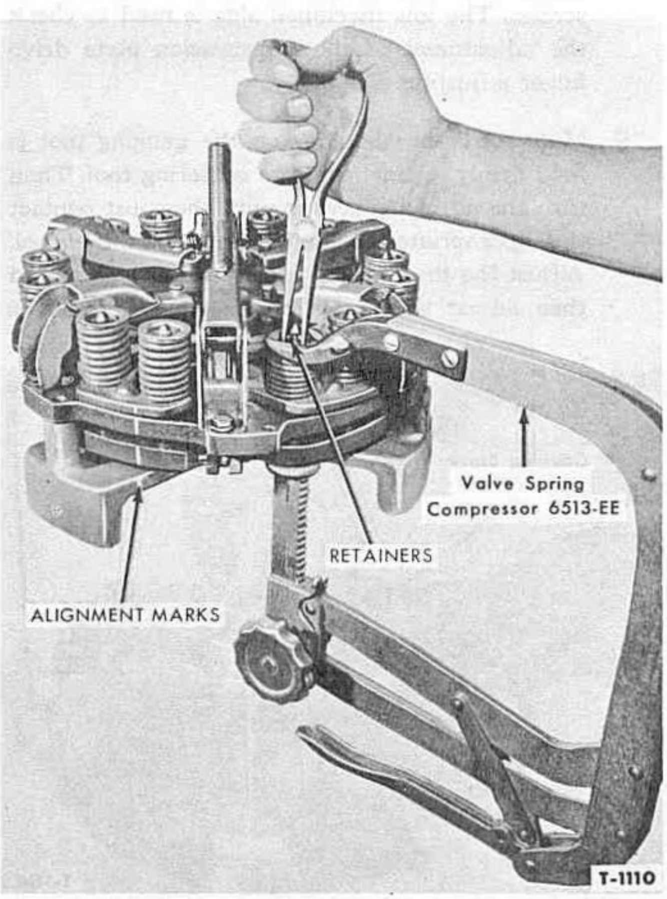

Figure 11—Removing or Installing Pressure Plate Springs

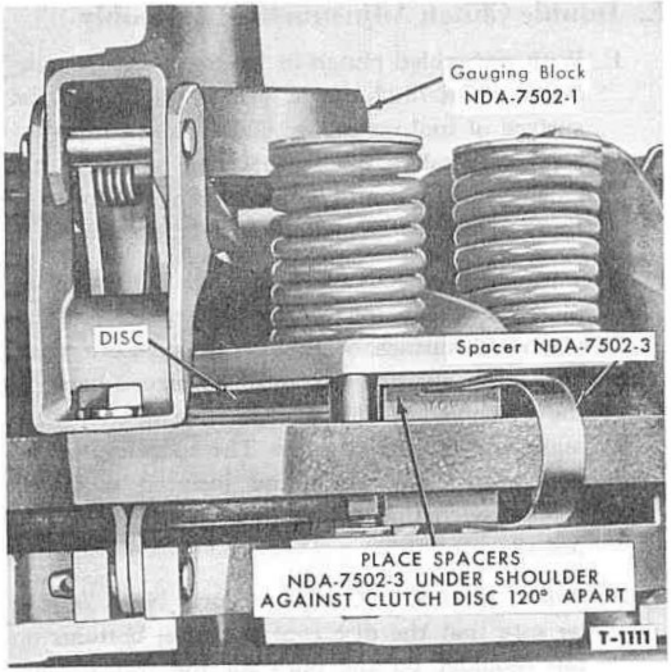

Figure 12—Adjusting Block Installed in Fixture

high machined side of the tool is used to check the adjustment of the P.T.O. finger adjusting screws. The low machined side is used to check the adjustment of the transmission plate drive finger adjusting screws.

5. Make sure the shoulder on the gauging tool is held firmly against the disc centering tool. Then turn the adjusting screws until they just contact the appropriate machined surface of the tool. Adjust the three lower fingers one at a time and then adjust the three top fingers to provide a 0.005" clearance between the machined surfaces and the heads of the adjusting screws.

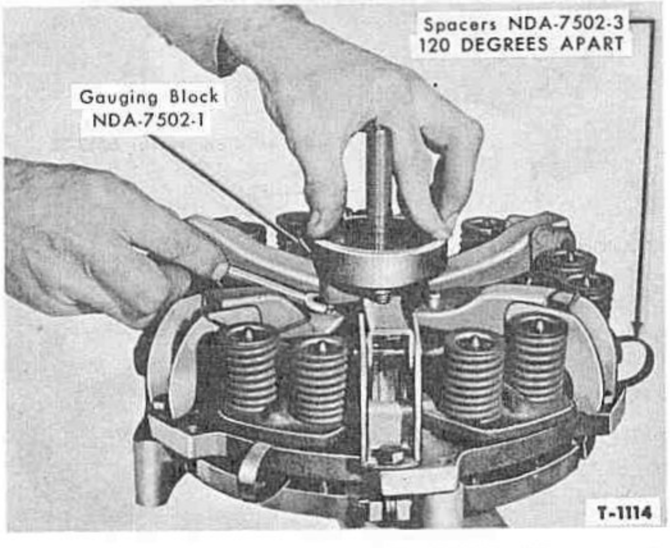

Figure 13—Adjusting Clutch Fingers

6. After completing the adjustment, perform step one in this procedure and remove the three screws.

F. Installation

Position completely assembled clutch on flywheel according to the alignment marks, Figure 14. Install the clutch plate and pressure plate assembly to flywheel with six retaining bolts. Tighten the bolts to 12-16 ft. lbs. torque.

NOTE: ***Whenever the current 9" double clutch assembly 311435 replaces the former double clutch assembly NDA 7502-B, there is a possibility that an interference may be encountered that will prevent proper functioning of the clutch. This interference is due to a thicker clutch pressure plate contacting the radius in the base of the counterbore of the flywheel.***

When this interference is encountered, the pressure plate can be modified by grinding a 1/8" to 3/16" x 45° uniform chamfer on the forward edge (flywheel side) of the pressure plate. This can be done by using a portable type grinder. However, caution must be taken not to damage the drive blocks and to be sure that the metal grindings are removed from the clutch assembly.

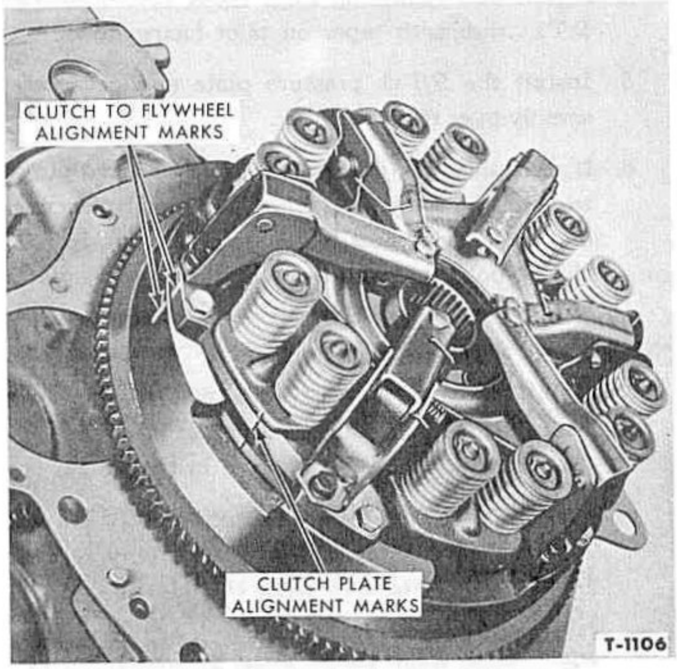

Figure 14—Double Clutch Installed

3. CLUTCH RELEASE SHAFT BUSHINGS

When the transmission has been removed from the tractor, the clutch release shaft bushings can be serviced as follows:

A. Removal

1. Disconnect the clutch release bearing retainer spring(s) and remove the bearing and hub assembly.
2. Remove the pin that retains the clutch release fork to the clutch release shaft and withdraw shaft and release shaft fork from transmission case.
3. Using Driver 807A or Driver 809 for the four speed and five speed transmission respectively, with Handle 814 from Bushing Driver Set 818, drive the bushings out of transmission case.

B. Installation

1. Position a new bushing with chamfered end started in bore in transmission case. Then, using Driver 807 and 809 for the four and five speed transmission respectively, with Handle 814, drive bushing into bore until end of bushing is flush with counterbore. Install the other bushing in the same manner.
2. Install clutch release fork and clutch shaft in transmission case. Be sure that shaft moves without binding. Align bore in shoulder of release fork with bore in shaft and install a new retaining pin.
3. Install the clutch release bearing and hub assembly. Position the release fork on hub and install the clutch release bearing spring(s).

4. CLUTCH PEDAL BUSHING

Clutch pedal bushings can be serviced as follows:

A. Removal

1. Place clutch pedal in a vise to facilitate bushing removal.
2. If pedal is from a tractor with a five speed transmission or with a four speed transmission on a 1958 or later unit, use Driver 807. On earlier four speed units use Driver 809. Using driver Handle 814, remove bushing from pedal.

B. Installation

1. Position a new bushing with chamfered end started in bore in pedal. Using the appropriate driver and handle, install bushing so that end of bushing is flush with linkage side of pedal.

5. CLUTCH PEDAL ADJUSTMENT

To obtain proper clutch operation and longer clutch life, it is important to maintain the recommended clutch pedal height and pedal free travel adjustments. Pedal free travel is defined as the distance that the clutch pedal can be depressed before resistance is met.

Pedal height adjustment is made by turning the adjusting clevis on the clutch release rod to lengthen or shorten the rod. Lengthening the clutch rod will decrease pedal height. Shortening the rod will increase the height.

The pedal free travel adjustment is made by loosening the lock nut on the pedal free travel adjusting screw that is located in the clutch release shaft arm. Turning the adjusting screw "IN" will increase free travel. Turning the adjusting screw "OUT" will decrease free travel. When the proper travel is established, be sure to tighten the lock nut securely.

The chart below provides the proper adjustment according to the type of transmission and clutch.

Transmission	*Clutch*	*Free Play*	*Pedal Height*
Four Speed*	Single	¾″	–
Four Speed**	Single	1½″	7″
Four Speed (offset)	Single	1½″	In line with Brake Pedal
Five Speed	Single	1½″	7″
Five Speed	Double	1½″	9⅜″

*Prior Tractor Serial #14257

**After Tractor Serial #14256

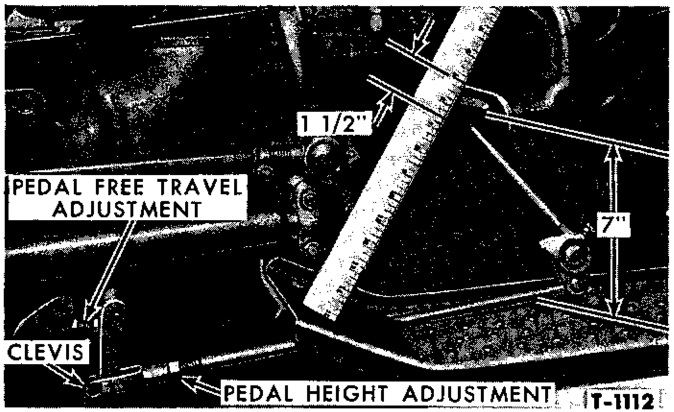

Figure 15—Measuring Clutch Pedal Free Travel

6. TROUBLE SHOOTING

Before removing the clutch disc or pressure plate assemblies from the tractor, attempt to isolate the trouble by following the symptoms listed below:

A. Noisy With Engine Not Operating

1. If the noise occurs when the clutch pedal is actuated and the engine is not operating, the noise is in the linkage or pressure plate.
2. Check and repair the linkage as necessary. If this does not correct the trouble, remove the pressure plate and repair or replace it as required.

B. Noisy When Free Travel is Eliminated

1. With the engine running, depress the clutch pedal enough to eliminate free travel. If noise is noted, it is probably due to a defective release bearing.
2. Replace the release bearing and make the necessary repairs to the pressure plate.

C. Clutch Slips

1. Check the clutch pedal and adjust as necessary.
2. If this does not correct the trouble, remove the clutch assembly and make the necessary repairs.

7. SPECIFICATIONS

Clutch Disc

Part No.	Diameter Inches	Transmission	Single Clutch	Double Clutch	Used For
NAA-7550	9	4 Speed	Yes	No	Trans.
NDA-7550-B1, 2	10	5 Speed	Yes	No	Trans.
NDA-7550-A1, 2	9	5 Speed	No	Yes	Trans.
NDA-77641-A1, 2	9	5 Speed	No	Yes	P.T.O.

Double Clutch

Part No.	Type	Spring Part No.	Spring Pressure	Free Length	Pedal Free Travel	Transmission Used
NDA-7502	Not Ventilated	NDA-7572-A	103 ± 5 @ 1.671″	2.767″	¾″—1″	5 Speed
311435	Ventilated	311342	119 ± 5 @ 1.671″	2.663″	¾″—1″	5 Speed

Single Clutch Assembly*

Part No.	Disc Size (Inches)	Type of Transmission	Pedal Free Travel (Inches)
NDA-7563-A	10	5 Speed	¾″ to 1″
09A-7563	9	4 Speed	¾″ to 1″

*Sold as a complete assembly only.

8. SPECIAL TOOLS

The following tools, except the clutch aligning arbor, are required to disassemble, assemble and adjust the double clutch. If a clutch aligning arbor is not available, an old transmission input shaft may be used as an aligning arbor.

Tool No.	Description
NDA-7502	Double Clutch Adjusting Fixture
6513-EE	Valve Spring Compressor
822	Clutch Aligning Arbor

Part TWO

CLUTCH, TRANSMISSIONS, REAR AXLE AND POWER TAKE-OFF

Chapter

II

Transmissions

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1. REMOVAL AND INSTALLATION

The procedures in this section apply to the five different type transmissions used in Ford Tractors. When removing a transmission from the tractor, make certain that the engine and the center housing are well supported. Also, make certain that the rope sling or chain is attached securely to the transmission and is capable of supporting the weight of the transmission, before attempting to lift it from the tractor.

A. Removal

1. Drain the oil from the transmission and from the center housing.
2. Remove the bolts that attach the manifold to the tractor hydraulic pump and to the engine and plate. Remove the manifold.
3. Remove the P.T.O. shift lever and plate assembly from the left side of the center housing (all except Select-O-Speed models).
4. Disconnect the starting motor cable at the starting motor. Remove the three bolts and lock washers that attach the starting motor to the engine rear end plate and remove the motor.
5. Disconnect the proof meter cable from the hydraulic pump.
6. Disconnect the starter wire at the starter button (all models except Select-O-Speed).
7. Remove the brackets that attach the tail pipe to the transmission case and center housing (models equipped with horizontal exhaust only).
8. Disconnect the taillamp and implement lamp receptacle wiring harness from the lead connection. Remove the harness from all attaching clips.
9. Remove the bolts that attach the throttle control arm brackets or accelerator control support to the transmission. Disconnect the throttle rod from the accelerator control lever on the industrial tractor only. Disconnect the throttle control rod from the bellcrank on all other tractors.
10. Place a floor jack under the transmission so that it can roll rearward. Raise the jack high enough to support the transmission.
11. Remove the right and left step plates from the tractor.

12. Disconnect the clutch linkage from the pedal if not equipped with a Select-O-Speed Transmission.
13. Disconnect the selector control cable and P.T.O. control cable at the transmission. Disconnect the safety switch and the oil warning light wires (Select-O-Speed models only).

Industrial Tractor: Remove the bolts that attach each side brace to the transmission and side rails. Remove the braces. Place a jackstand under each side rail just ahead of the fenders. Remove both fenders from the tractor.

General Purpose Tractor: Drive wedges between the axle and front support, as shown in Figure 1, to prevent the tractor from tipping. Disconnect the radius rods from the transmission.

14. Disconnect the drag link from each steering Pitman arm on all tractors except industrial models.
15. Remove the four bolts that attach the steering housing to the transmission case.

    IMPORTANT: ***Place a thin board over the top of the battery to prevent the battery terminals from contacting the fuel tank.***

    Position a sling under the steering Pitman arms and raise the steering housing approximately 1½″ from the transmission case. Install a jackstand under the oil pan.

    NOTE: ***On tractors without Pitman arms, lift the steering housing with a rope sling attached to the steering wheel hub or with a small chain and bracket secured under the steering wheel nut.***
16. Cradle the front "Row Crop" models and install jackstands under the side rails to prevent it from tipping.
17. Remove the transmission to engine rear end plate mounting bolts and separate the engine from the transmission. If it is necessary to use pry bars, be careful not to damage the mating surfaces.

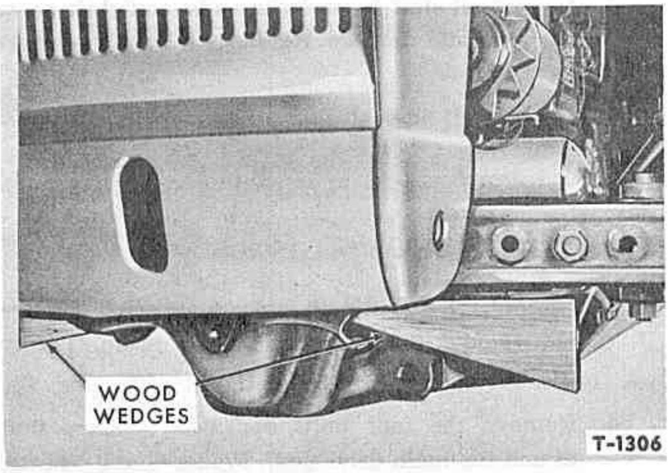


Figure 1—Wedges Installed

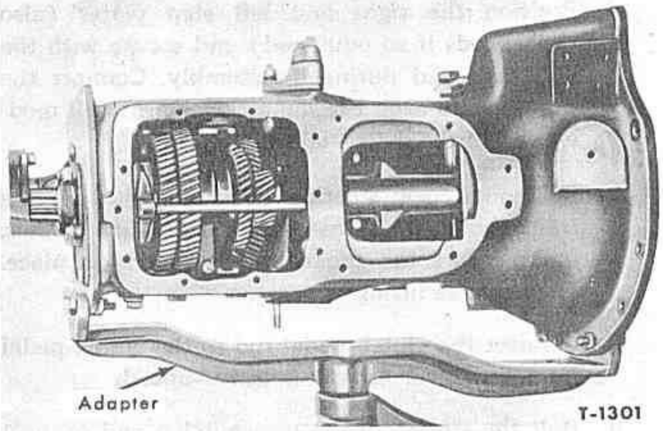


Figure 2—Transmission Mounted on Engine Stand

18. Position a hoist over the transmission. Bolt a short piece of chain to the transmission's 2 rear steering housing mounting holes. Hoist the weight off the floor jack supporting the transmission. Reposition the floor jack under the hydraulic reservoir part of the center housing.
19. Remove the transmission-to-center-housing attaching bolts and nuts, and separate the transmission from the center housing. Discard the gasket and hydraulic line "O" rings. Mount the transmission on a support stand or bench, Figure 2.

B. Installation

1. Install a new transmission-to-center-housing gasket and new "O" rings. Support the gasket in position on two top attaching bolts and join the transmission and center housing. Install the bolts and nuts. Torque the nuts to 40-50 ft. lbs.; the bolts to 60-70 ft. lbs.
2. Position a floor jack under the transmission and remove the hoist attachment.
3. Install the P.T.O. shifter plate and lever.
4. Align the front end of the transmission with the engine. Move the transmission into place, making sure the input shaft splines engage the clutch splines. Torque the ⅝″ attaching bolts to 135-150 ft. lbs., and the $\frac{7}{16}$″ bolts to 60-70 ft. lbs.

   NOTE: ***It may be necessary to turn the flywheel with a screwdriver to align the clutch splines with the splines on the input shaft.***
5. Remove the engine and transmission supports. Remove the front cradle on "Row Crop" tractors.

Industrial Models: Install the two side rail braces, but do not tighten the bolts. Install the fenders and then tighten all side rail brace attaching bolts.

6. Position the right and left step plates (also radius rods if so equipped) and secure with the nuts removed during disassembly. Connect the drag link to each Pitman steering arm (all models except the industrial tractor).

7. Position a new steering housing gasket on the transmission on all gasoline and LP-Gas models, making sure the choke rod bracket is in place. Remove the lifting apparatus.

8. Connect the clutch pedal rod to the clutch pedal on all models except Select-O-Speed.

9. Bolt the starter to the transmission and connect the cable.

10. Attach the tail pipe to the brackets on the center housing and transmission case if equipped with a horizontal exhaust.

11. Attach the starter wire to the starter button on all models except Select-O-Speed.

Select-O-Speed Models: Connect the selector cable and the P.T.O. cable to the transmission. Connect the safety switch and oil warning light wires.

12. Insert the taillight wiring harness in the clips on the transmission and center housing. Connect it to the rear outlet and taillamp.

13. Connect the Proof-Meter to the hydraulic pump.

14. Use new "O" rings and attach the manifold to the transmission and the tractor hydraulic pump.

15. Secure the throttle control arm bracket or accelerator control support to the transmission. Connect the throttle control rod to the bellcrank (except industrial tractors). Connect the throttle rod to the accelerator control lever on industrial tractors only.

16. Make sure the drain plug is tightened in the center housing and in the transmission. Fill the center housing and the transmission to the proper level with the specified lubricant.

2. CLEANING AND INSPECTION—ALL EXCEPT SELECT-O-SPEED

A. Cleaning

1. After the transmission sub-assemblies have been disassembled, clean all old lubricant and dirt from the parts with a suitable cleaning solvent.
2. To clean the bearings, rotate the bearings in cleaning solvent until all of the old lubricant has been removed. Dry the bearings with compressed air, being careful not to spin them. Slowly turn the bearings by hand while directing the air at right angles, to prevent them from spinning.
3. After inspecting the bearings as outlined in subparagraph B, lubricate the bearings thoroughly, then wrap each bearing in a clean, lint-free cloth until ready for use.

B. Inspection

1. Inspect the transmission case for cracks, worn bearing bores, damaged threads, or other damage. Replace the case if any of these conditions are evident.

2. Replace all gears, couplings and connectors that are worn, chipped, broken, or damaged. Small nicks or burrs should be removed with a fine stone.

3. Inspect all bearings for wear, scores, discoloration from overheating or for missing rollers. Check bearing races for wear, cracks, or scores. Check bearings for worn or bent retainers. Replace all defective bearings and races.

4. Inspect all shift lever forks, rails, and shift gates for wear and damage. Replace all defective parts as required.

5. Replace all oil seals and gaskets at time of overhaul.

3. FOUR SPEED TRANSMISSION

A. Disassembly

1. Remove the nine bolts that attach the cover assembly to the transmission case and lift the cover off the case.

2. Remove the shift fork rail spring and detent ball that are retained in place by the cover.

3. Disconnect the clutch release bearing springs and remove the bearing and hub assembly, Figure 3.

4. Remove the four bolts and lock washers that attach the main drive gear, Figure 4, and bearing retainer assembly to the transmission case. Re-

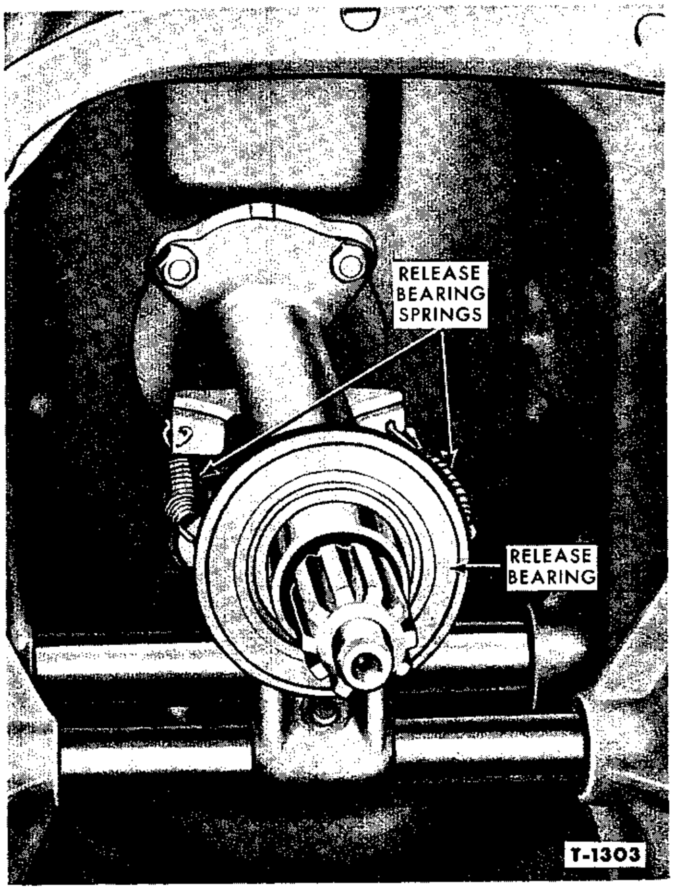


Figure 3—Removing Clutch Release Bearing

move the drive gear and retainer assembly as a unit.

5. Loosen the lock nut on the lock screw in the 1st and 3rd gear shifter fork, Figure 5. Back off the screw and slide the shifter rail out of the transmission case. Remove the shifter fork from its position in the mainshaft connector coupling.
6. Remove the shifter plate pivots and gaskets from each side of the housing and lift the plates out of the case.
7. Remove the four bolts and lock washers holding the mainshaft rear bearing retainer, Figure 4, to the case and remove the retainer. Keep the shim pack together to facilitate assembly.
8. Lift the mainshaft gear cluster out of the transmission. It may be necessary to push the reverse gear shifter fork and 2nd and 4th gear shifter fork, Figure 5, toward the front of the case to provide clearance for removing the mainshaft.
9. Remove the shifter rail spring seat, gasket, spring and detent ball from the right side of the transmission case. Loosen the lock nut on the lock screw in the 2nd and 4th gear shifter fork and back off the screws. Remove the shifter rail cap plug from the rear of the transmission case and pull the shifter rail out of the case. Remove the shifter fork from its position in the countershaft connector coupling.
10. Remove the four bolts and lock washers that hold the countershaft front bearing retainer, Figure 4, to the transmission case.
11. Remove the four bolts and lock washers that attach the P.T.O. support and shifter assembly to the rear of the transmission case. Remove the assembly and keep the shim pack together to permit proper assembly.
12. Slide the countershaft assembly, Figure 4, to the rear and lift it out of the case.
13. Remove the shifter rail spring seat gasket, spring and detent ball from the left side of the transmission case.
14. Loosen the lock nut on the lock screw in the reverse gear shift fork, Figure 5, and back off the lock screw. Remove the shifter rail cap plug from the rear of the transmission case and pull the reverse gear shift rail out of the housing. Remove the shifter fork from its position on the reverse idler driven gear.
15. Pull the reverse idler shaft from its bore in the case and lift the gears and thrust washers out of the transmission.
16. Remove the snap ring and "O" ring from the reverse idler shaft, Figure 4.

B. Repair of Sub-Assemblies

Gearshift and Cover: The following procedure covers the disassembly and assembly of the gearshift and cover:

1. Remove the starter button and gasket from the cover by removing the nut, lock washer and starter button support, Figure 5.
2. Using Shift Lever Spring Compressor 7227, as shown in Figure 6, compress the gearshift lever spring and remove the spring seat.
3. Loosen the shift lever dust seal from the cover and remove the shift lever from the cover, Figure 5.
4. Insert the shift lever in the cover and reposition the dust seal.
5. Install the gear shift lever spring and spring seat, Figure 6. Move the lever to check for proper seat position. A clicking noise will indicate that the spring seat is improperly positioned.
6. Install the starter button and new gasket, starter button support, lock washer and nut. Tighten the nut and bend the tang on the lock washer to secure the nut.

Main Drive Gear: The following procedure covers the disassembly and assembly of the main drive gear:

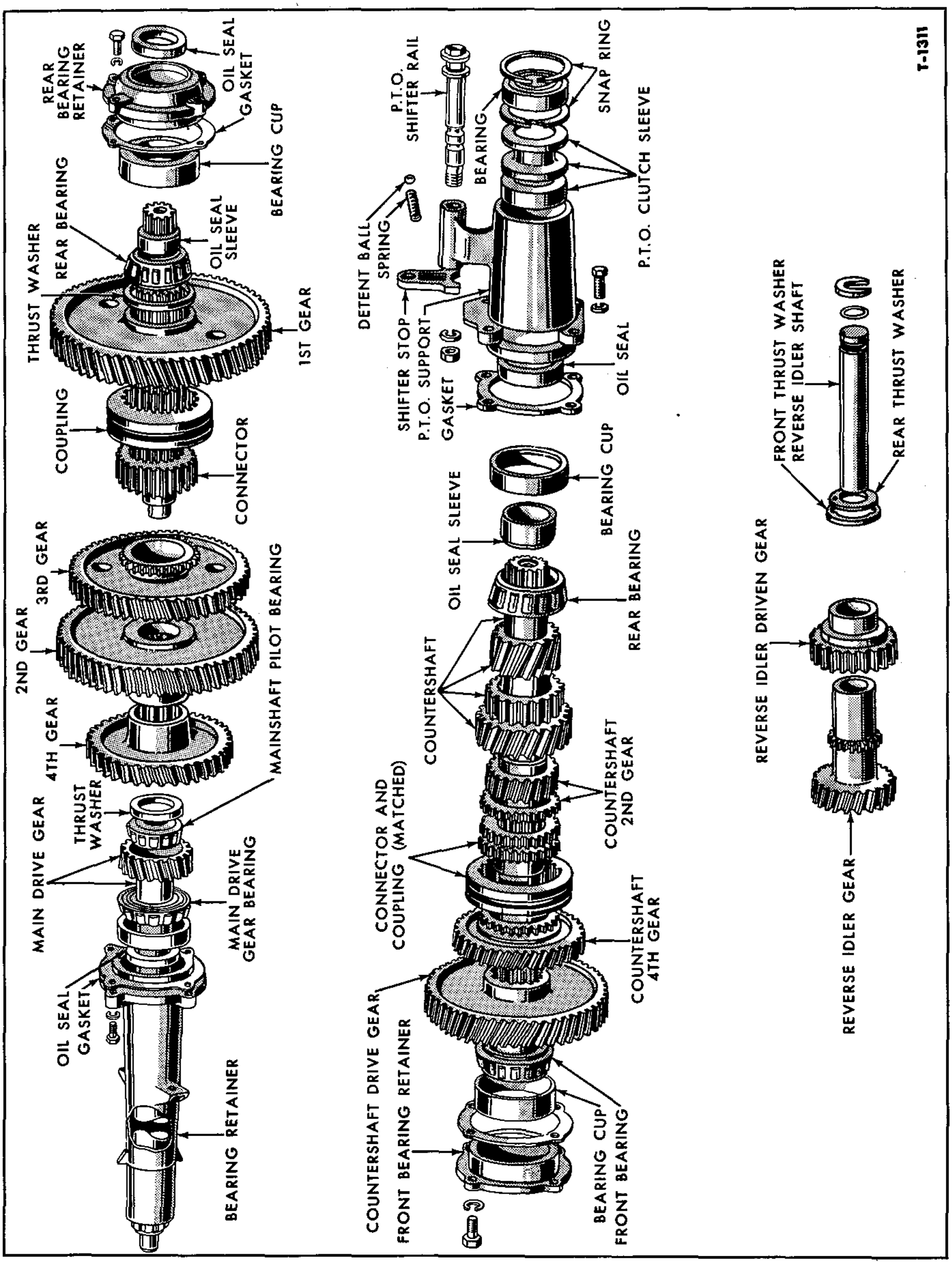


Figure 4—Transmission—Disassembled

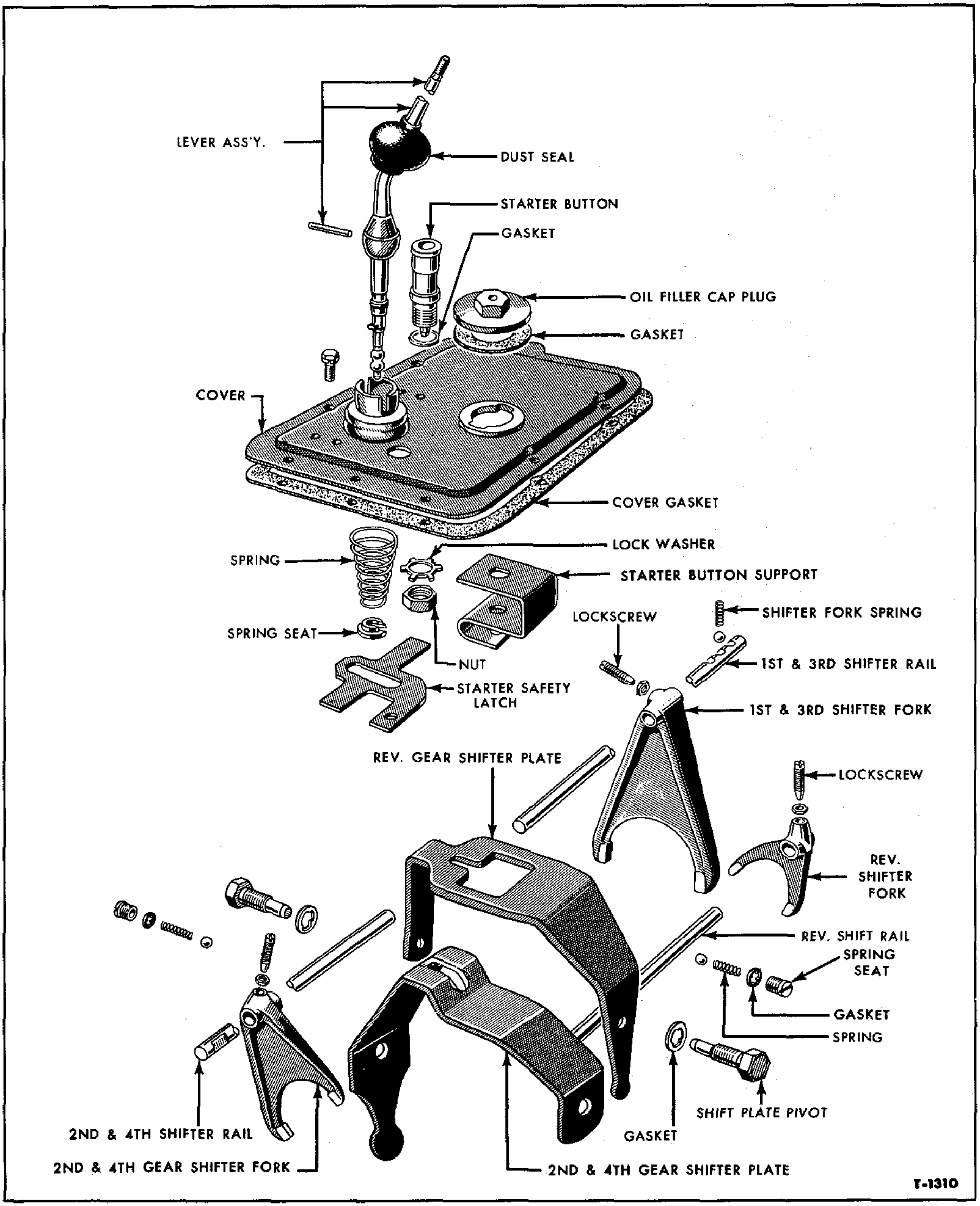


Figure 5—Gearshift Cover—Disassembled

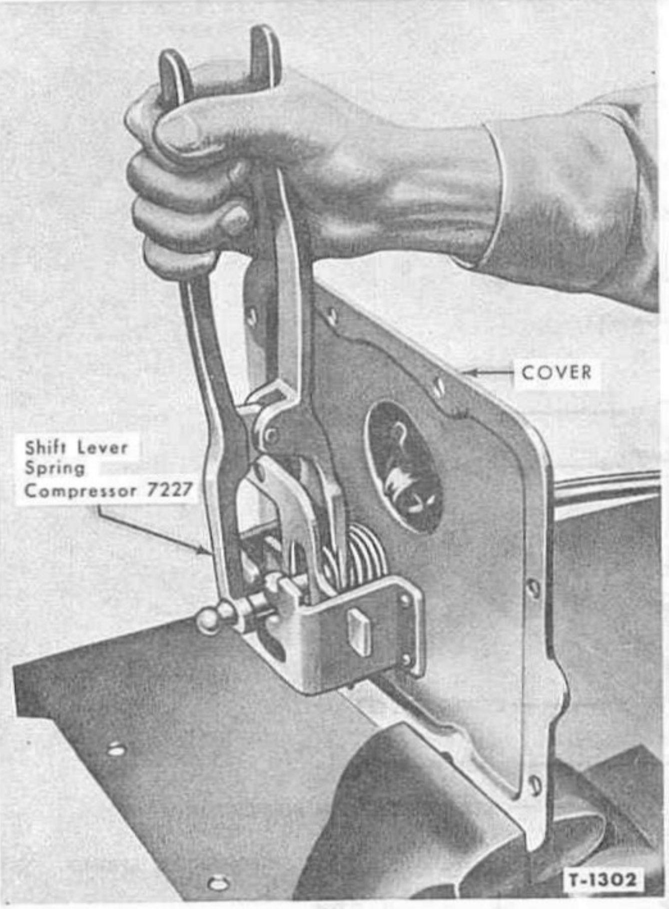


Figure 6—Removing Shift Lever Spring

1. Slip the main drive gear out of the bearing retainer.

2. Remove the main drive gear bearing with the tools illustrated in Figure 7. Remove the bearing cup from the retainer with Bearing Cup Pulling Attachment 943 and Slide Hammer 943-S. Remove the oil seal using Puller 956 and Slide Hammer.

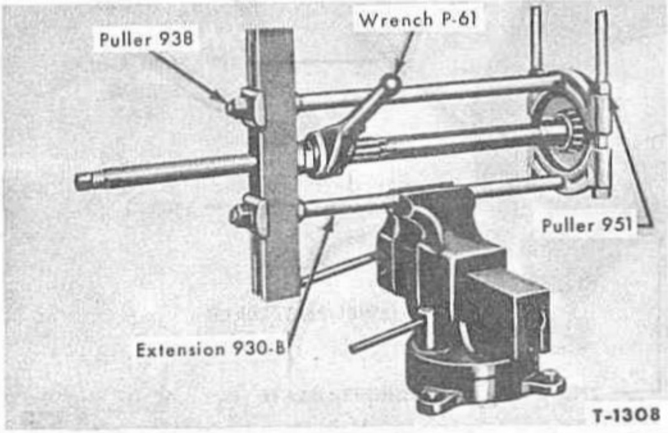


Figure 7—Removing Main Drive Gear Bearing

3. Place a sleeve approximately two inches long and with an I.D. that will contact the inner race of the bearing on two arbor press split plates. Place the bearing in position on the gear and insert the splined end of gear through the sleeve until the inner race of bearing rests on top of the sleeve. Place a suitable driver on the face of the gear, then press the gear into the bearing until the bearing bottoms on the gear.
4. With Driver 630-9, install a new oil seal in the retainer with the lip of seal facing toward the rear. Coat the sealing surface of the seal with Lubriplate or equivalent. With Driver 630-15, press the bearing cup into the retainer.
5. Coat the splines of main drive gear with engine oil and slide the gear assembly into the bearing retainer. Rotate the gear during assembly to prevent damage to the oil seal.

Mainshaft: The following procedure covers the disassembly and assembly of the mainshaft and mainshaft rear bearing retainer.

1. With Bearing Cup Pulling Attachment 943 and Slide Hammer 943-S, remove the rear bearing cup and oil seal from the retainer, Figure 4.
2. Remove the 4th gear, thrust washer and front bearing, with Gear Puller 1002 as shown in "A", Figure 8.
3. Slide the 2nd gear off the shaft.
4. Remove the 1st gear, thrust washer, rear bearing and oil seal sleeve with Gear Puller 1003, as shown in "B", Figure 8.
5. Slide the mainshaft connector coupling, the main-

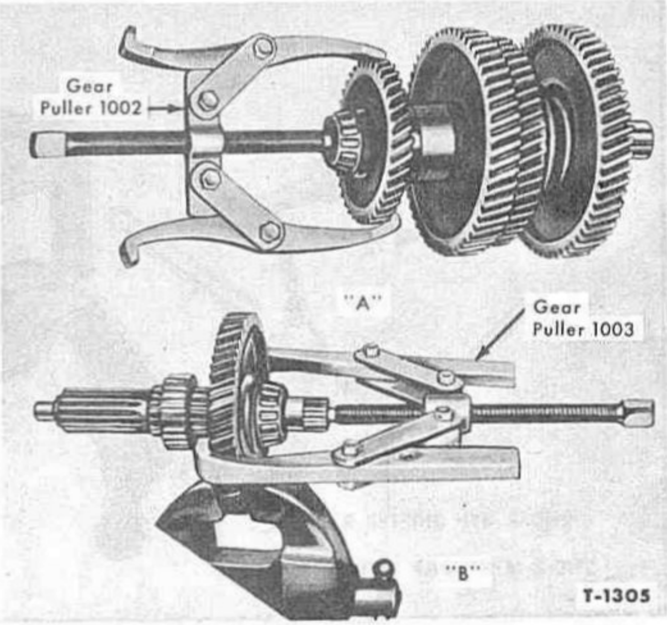


Figure 8—Removing Mainshaft Gears and Bearings

shaft coupling connector, and 3rd gear off the shaft.

6. Place the 2nd gear, 4th gear and thrust washer on the front of the mainshaft.
7. With an arbor press and installer that fits on the inner race of the mainshaft front bearing, press the bearing on the mainshaft.
8. Place the 3rd gear, 1st and 3rd gear connector and coupling, 1st gear and thrust washer on the rear of the shaft.
9. In a similar manner as step 8, press the rear bearing on the end of shaft. Press the oil seal sleeve on the mainshaft, using a suitable hollow sleeve.

Countershaft: The following procedure covers the disassembly and assembly of the countershaft.

1. Remove the bearing cup from the front bearing retainer, Figure 4, with Bearing Cup Pulling Attachment 943 and Slide Hammer 943-S.
2. With Bearing Pulling Attachment 951 and Puller 1002, as shown in "A", Figure 9, pull the countershaft rear bearing and oil seal sleeve off the countershaft.
3. With Puller 1003, as shown in "B", Figure 9, pull the countershaft drive gear and front bearing off the countershaft.
4. Slide the countershaft 4th gear, 2nd and 4th gear connector and coupling off the countershaft. Slide the countershaft, 2nd gear off the shaft.
5. Press the bearing cup into the front bearing retainer with Installer 630-15.

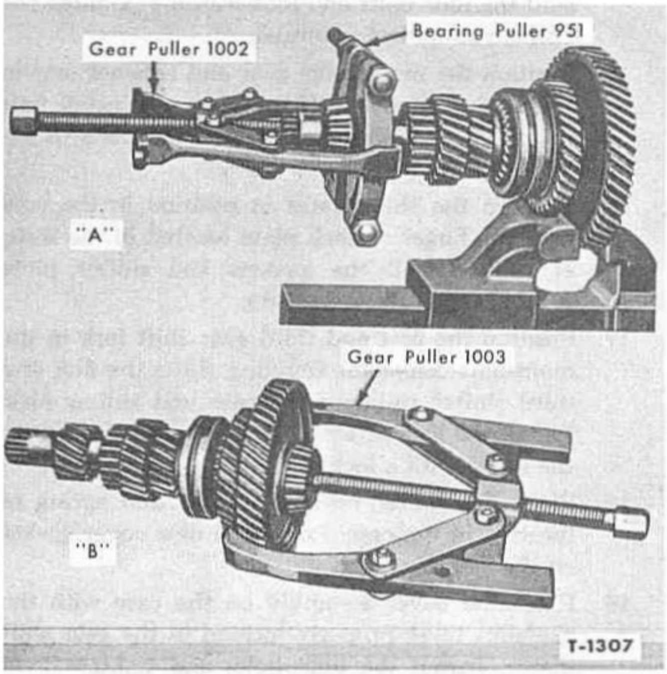


Figure 9—Disassembling Countershaft

6. Install in order, on the countershaft, the countershaft 2nd gear, 2nd and 4th gear connector and coupling, countershaft 4th gear and countershaft drive gear.
7. With an arbor press and an installer that fits on the inner race of the countershaft front bearing, press the bearing on the countershaft.
8. In a similar manner, press the rear bearing on the countershaft. Press the countershaft oil seal sleeve on the countershaft, using a suitable hollow sleeve.

P.T.O. Support: Removal of this assembly from the transmission is accomplished with the removal of the countershaft rear bearing retainer. The following procedure covers the disassembly and assembly of the P.T.O. support.

1. Remove the nut and lock washer that retains the P.T.O. shifter stop to the shift rail and remove the shifter stop from its location in the P.T.O. clutch sleeve, Figure 4.
2. Remove the shift rail, ball, and spring from the support housing.
3. Remove the clutch sleeve from the assembly.
4. The bearing cup must be removed in order to replace the oil seal. The cup and seal can be removed with Bearing Cup Pulling Attachment 943 and Slide Hammer 943-S.
5. Install a new oil seal and the bearing cup in the support housing using the arbor press and Step Plates 630-12 and 630-15 respectively. Coat the sealing surface of the seal with Lubriplate or equivalent.
6. Place the P.T.O. clutch sleeve in the support housing with wide land end of sleeve facing toward the bearing cup end of the support.
7. Install the shift rail detent spring and ball, Figure 4. Push the ball down far enough to permit insertion of shifter rail part way into the housing. Then place the shifter stop in the groove in the clutch sleeve and push the shifter rail into the shifter stop. Install the lock washer and nut and tighten nut securely.

C. Assembly

The four speed transmission can be assembled in the transmission case by reversing the sequence of disassembly operations. However, before beginning a complete buildup, the mainshaft preload must be checked. This is accomplished by installing the mainshaft in the transmission as detailed in paragraphs 12 through 17, at this time. Check mainshaft preload with Preload Gauge 4609-A in the same manner as illustrated in Figure 10. Preload should be 20-35 in. lbs. when lower gear forks are in neutral and top gear forks not installed, with the gears and bearings lightly oiled. Add or remove shims as required to provide proper preload. After establishing the correct preload, remove the mainshaft from the transmission case and begin the complete build-up. Lubricate all gears with transmission lubricant before installing them in the case.

1. Install a new "O" ring and snap ring on the idler shaft.
2. Position the reverse idler gear, reverse idler driven gear and thrust washers in the transmission case. Figure 4 shows their relative position in the transmission case. The oil grooves in the front thrust washer must face the rear thrust washer and the tang on back face of rear washer must be located in the groove cast in the transmission case.
3. Start the reverse idler shaft in the bore in the case. Align the washers and gears and slide the shaft into place.
4. Position the shifter fork over the reverse idler driven gear and install the shifter rail in the housing and fork. Install the lock screw in the shifter fork and secure screw with a lock nut. Install the reverse shifter rail cap.
5. Install the detent ball, spring, gasket and shifter rail spring seat in the left side of the case.
6. Position the countershaft and gear cluster assembly in the transmission case.
7. Place the countershaft front bearing retainer and gasket in position and install the four bolts and lock washers. Tighten the bolts to 25-30 ft. lbs. torque.
8. Place the P.T.O. support and shifter assembly in position in the rear of the case. Be sure the correct shim pack is located between the support assembly and case. Install the four bolts and lock washers and tighten to 25-30 ft. lbs. torque.
9. At this time, check the countershaft preload with Preload Gauge 4609-A, as shown in Figure 10. The preload should be 15-30 in. lbs. with the bearings and gears lightly lubricated. Add or remove shims as required to obtain the correct preload.

   NOTE: ***The reverse idler gear assembly should be in place (shifter not engaged) when the countershaft preload is checked. If mainshaft preload is on the low side, countershaft preload should be on the low side also.***
10. Place the 2nd and 4th gear shifter fork in position in the coupling and install the shifter rail in the case and fork. Install the lock screw in the shifter fork and secure the screw with the lock nut. Install the shifter rail cap.

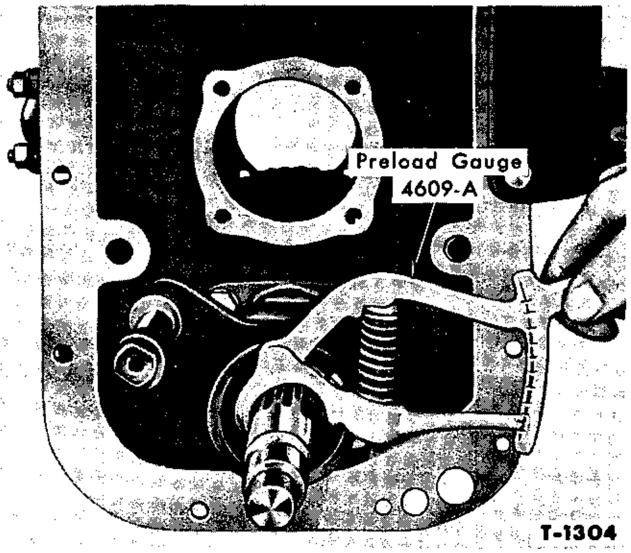


Figure 10—Checking Countershaft Bearing Preload

11. Install the detent ball, spring, gasket and shifter rail spring seat in the right side of the transmission case.
12. Position the mainshaft and gear cluster assembly in the transmission case.
13. With a suitable installer, press a new oil seal in the rear bearing retainer. Coat the seal contact surface with a light film of Lubriplate or equivalent. With a suitable installer, press the bearing cup in the retainer.
14. Place the correct shim pack and retainer assembly in the rear of the transmission case and install the four bolts and lock washers. Tighten the bolts to 25-30 ft. lbs. torque.
15. Position the main drive gear and retainer assembly at the front end of the case and install four bolts and lock washers. Tighten the bolts to 25-30 ft. lbs. torque.
16. Position the shift plates in position in the case with the finger of each plate located in the shifter rails. Install the gaskets and shifter plate pivots in the side of the case.
17. Position the first and third gear shift fork in the mainshaft connector coupling. Slide the first and third shifter rail into the case and shifter fork. Install the lock screw in the shift fork and secure the screw with a lock nut.
18. Place the shifter rail detent ball and spring in location in the case. Position a new cover gasket on the case.
19. Place the cover assembly on the case with the gearshift lever properly located in the gear shift plates. Install the nine bolts and tighten them securely.

4. FIVE-SPEED TRANSMISSION

The following is a complete disassembly of the transmission. However, in most cases it is not necessary to disassemble the entire transmission to repair or replace components.

The double clutch five speed transmission, Figure 11, utilizes a separate input shaft to drive the P.T.O. countershaft gear. The single clutch transmission does not have a separate P.T.O. input shaft. Instead, the transmission input shaft incorporates a gear which drives the P.T.O. countershaft gear. Any difference in procedure between the single and double clutch transmission will be noted in the text.

A.· Disassembly

Reference to right and left side are made facing the rear of the transmission.

1. Remove the shift lever retaining nut and flat washer, then remove the shift lever. Remove the Woodruff key and spring.
2. Remove the transmission cover assembly and gasket, Figure 12.
   NOTE: ***To replace a defective starter button, remove the nut, washer, and lock washer from the underneath side of the cover.***
3. Remove the reverse idler gear and housing assembly from the right side of the transmission case.
4. Pry the clutch release bearing fork spring to one side to release it from the transmission case. Turn the fork forward and remove the clutch release bearing.
5. Remove the bolt and lock nut from the fork and withdraw the clutch release shaft to remove the fork and spring.

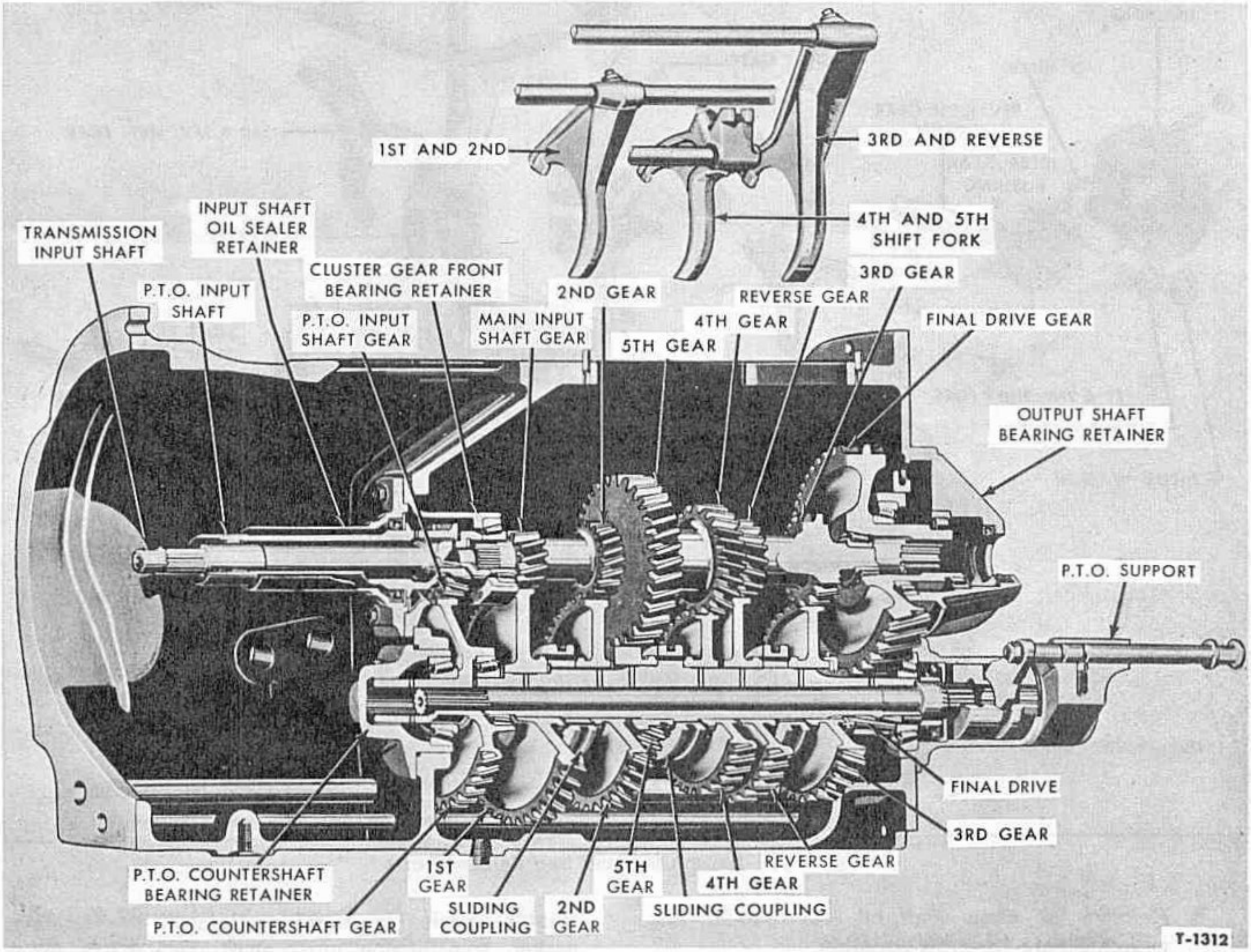


Figure 11—Five Speed Transmission—Double Clutch

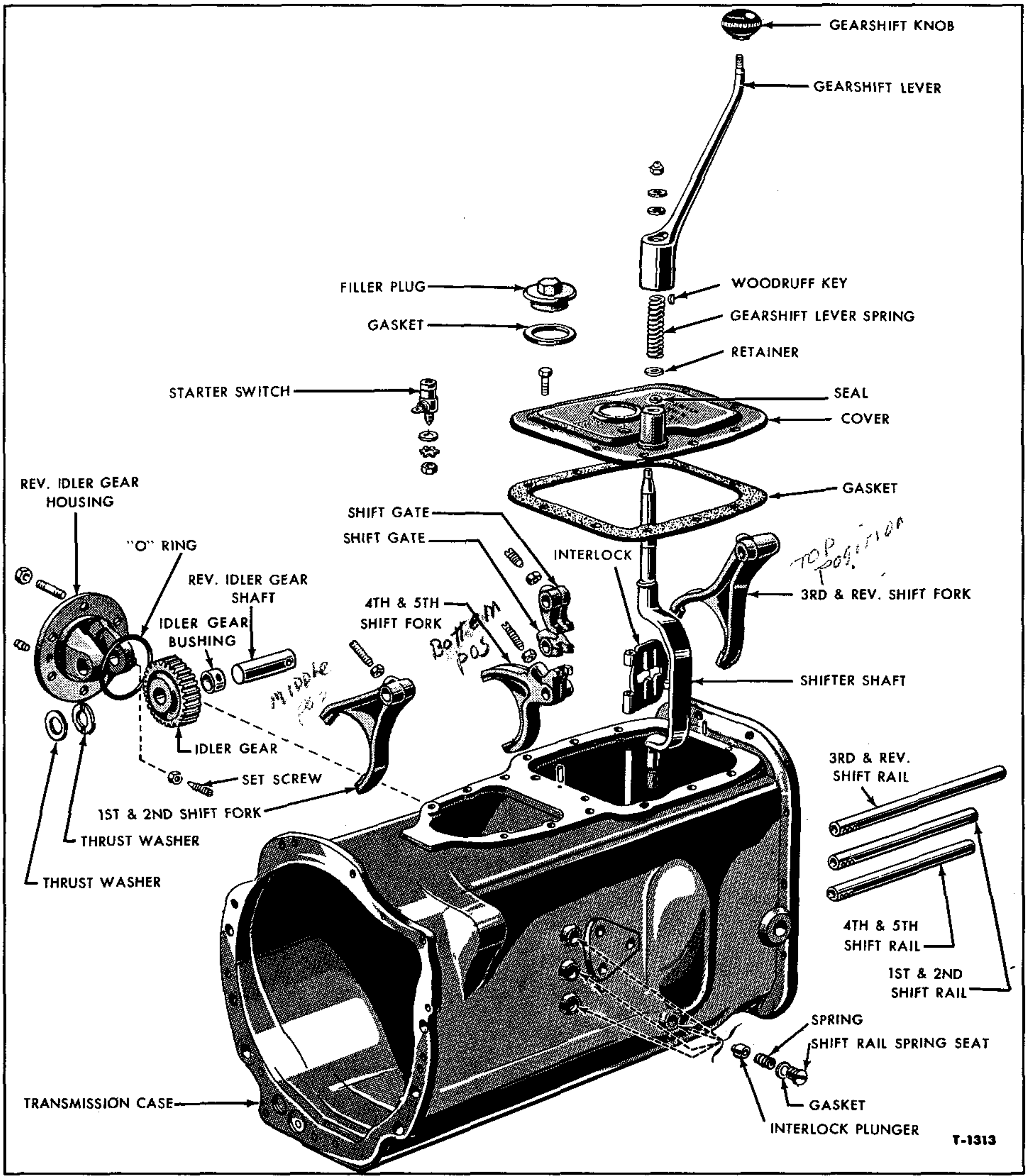


Figure 12—Gearshift Cover and Related Parts

6. Remove the input shaft, oil seal retainer, and gasket, Figure 13, as an assembly.

Double Clutch Transmission: Remove the retainer, gasket, transmission input shaft, and P.T.O. input shaft as an assembly.

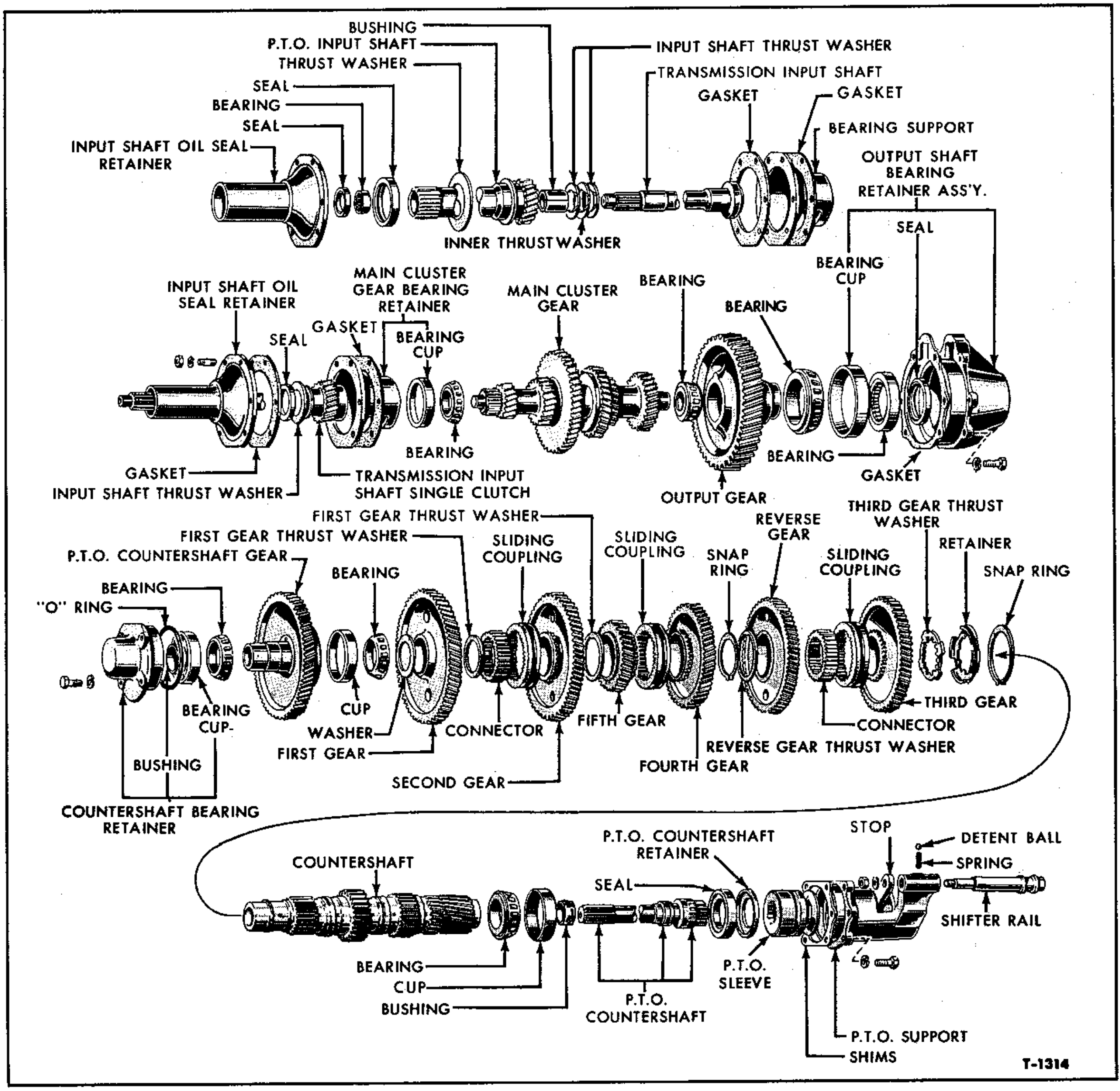


Figure 13—Gears and Component Parts

7. Remove the main cluster gear front bearing retainer and gasket.
8. Remove the six cluster gear rear bearing retainer attaching bolts and lock washers, then remove the retainer and shim pack. Keep the shim pack intact for reassembly purposes.
9. Lift the main cluster gear up and forward to clear the countershaft second gear, and remove the assembly from the case, rear end first.
10. Remove the six bolts and lock washers that secure the P.T.O. support, Figure 11, to the rear of the transmission and remove the support. Keep the shims intact and with the support to facilitate assembly.
11. Remove the three shift rail spring seats and gaskets from the left side of the transmission case and remove the springs and plungers, Figure 12.
12. Remove the top expansion plug from the rear of the transmission case behind the shift rail. Drive the plug from the case with a punch and hammer.
13. Loosen the lock nuts and remove the two set

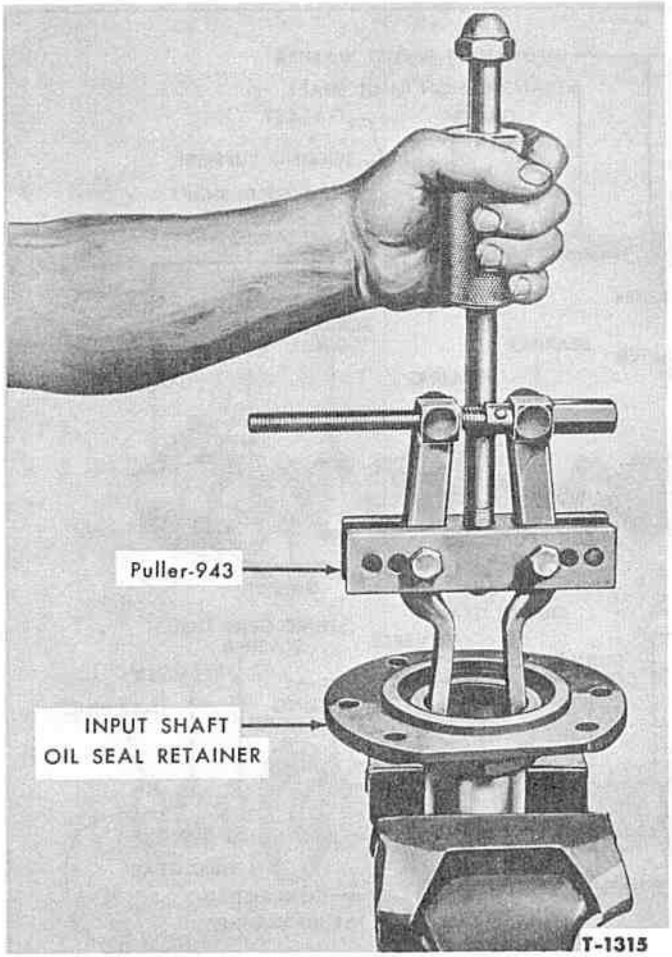


Figure 14—Removing Oil Seal from Retainer

screws from the 3rd and reverse shifter fork and gate on the top shift rail. Remove the rail through the expansion plug hole. Remove the shifter fork and gate, tag them for identification and place them with their rail.

NOTE: ***It may be necessary to lift or jiggle the countershaft to prevent it from binding on the rail.***

14. Remove the transmission output gear, Figure 13, and remove the remaining expansion plugs.
15. Loosen the lock nuts and remove the set screws from the shifter fork on the middle rail. Remove the middle rail and the 1st and 2nd gear shifter fork and gate. Tag the shifter fork and gate for identification.
16. Loosen the lock nut and remove the set screw from the combination 4th and 5th gear shifter fork and gate on the bottom rail. Remove the bottom rail and shifter fork and tag them for identification.
17. Remove the interlock and hinge rod, Figure 12, by moving the rod up through the hole in the top of the transmission case. If this hole does not line up with the rod, remove the socket head plug from the bottom of the case and move the rod out through that opening.
18. Remove the detent seat, gasket, spring, and plunger for the shifter shaft, Figure 12, from the left side of the transmission case, then remove the shifter shaft.
19. Working from the rear of the case, remove the P.T.O. countershaft from the countershaft assembly, Figure 13. Remove the four front countershaft bearing retainer attaching bolts and lock washers, Figure 11. Remove the retainer and "O" ring seal from the case. Move the countershaft as far to the rear as possible and then lift it out of the case, front end first.
20. Remove the P.T.O. countershaft gear from the transmission case, Figure 11.

B. Repair of Sub-Assemblies

The following information provides procedures for disassembly, and assembly of the transmission components. Where possible, illustrations are used to show the special tools that are required.

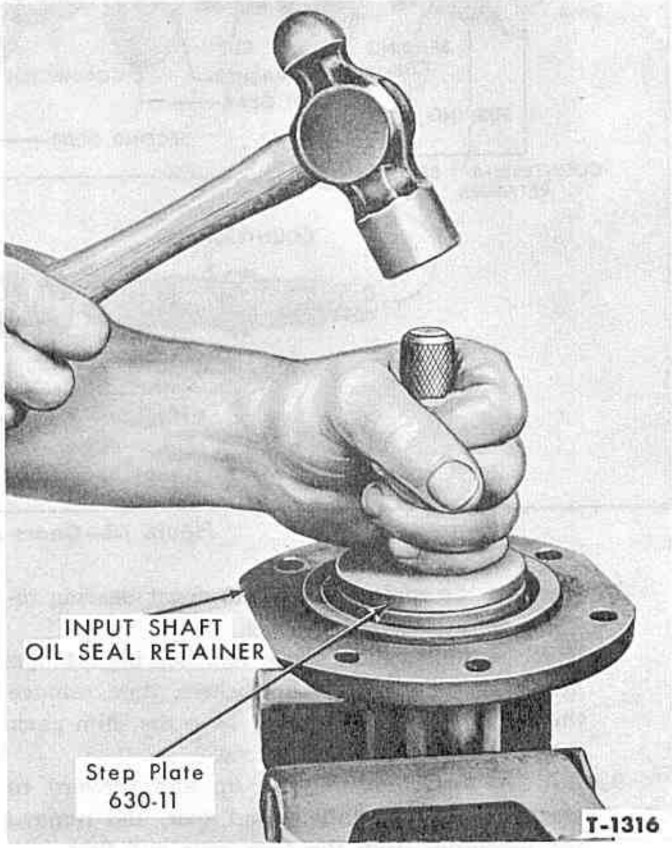


Figure 15—Installing Oil Seal in Input Shaft Oil Seal Retainer

Input Shaft Oil Seal Retainer:

1. Pull the oil seal with Puller 943 and a slide hammer as shown in Figure 14.
2. Coat the wiping surface of a new seal with Lubriplate or equivalent and install it in the input shaft seal retainer with Step Plate 630-11 as shown in Figure 15. Make certain that the lip of the seal faces toward the rear of the retainer.

Cluster Gear Front Bearing Retainer:

1. Remove the bearing cup with Puller 956-2 and a slide hammer as shown in Figure 16.
2. Install the bearing cup in the bearing support with Step Plate 630-12 or a wood block and hammer, Figure 17.

P.T.O. Input Shaft (Double Clutch Transmission):

1. Remove the oil seal, needle bearing, and bushing with Puller 956-2 and a slide hammer as shown in Figure 18.
2. Pack wheel bearing grease in the shaft area behind the needle bearing. Press the stamped end of the bearing to a 0.76″ depth from the front end of the shaft and pack grease in front of the bearing.
3. Coat the wiping surface of a new oil seal with Lubriplate or equivalent and press it in the shaft, using Step Plate 630-4. See Figure 19.
4. Drive a new bushing in the retainer using Bushing Driver Set 818. Ream the bushing so there is 0.003″ to 0.005″ clearance for the shaft.

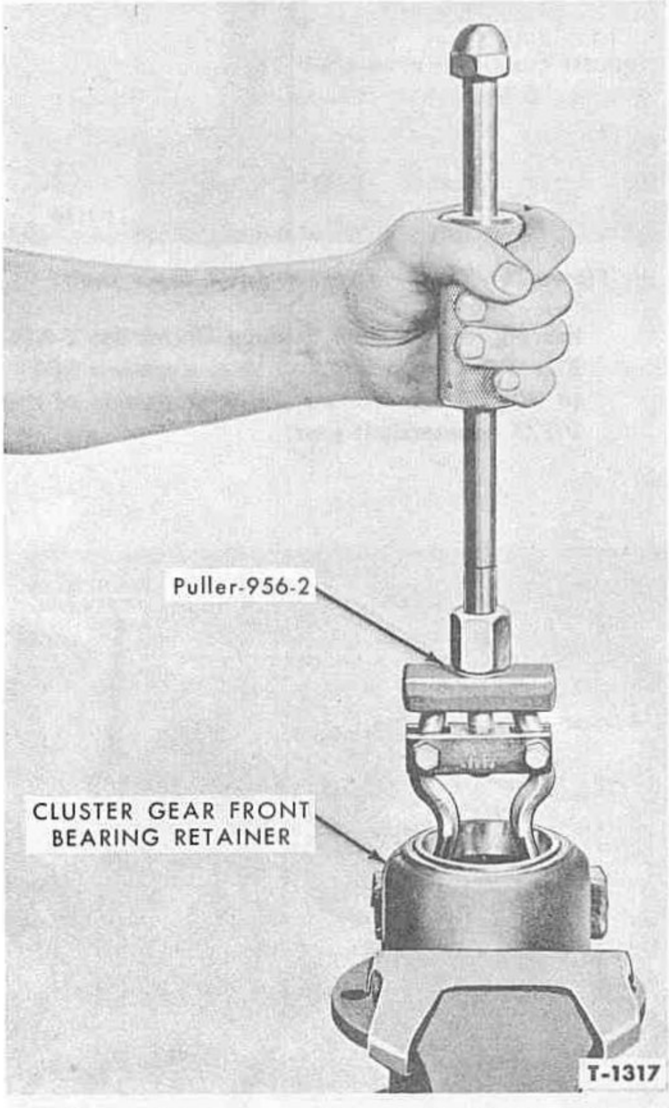


Figure 16—Removing Bearing Cup from Cluster Gear Front Bearing Retainer

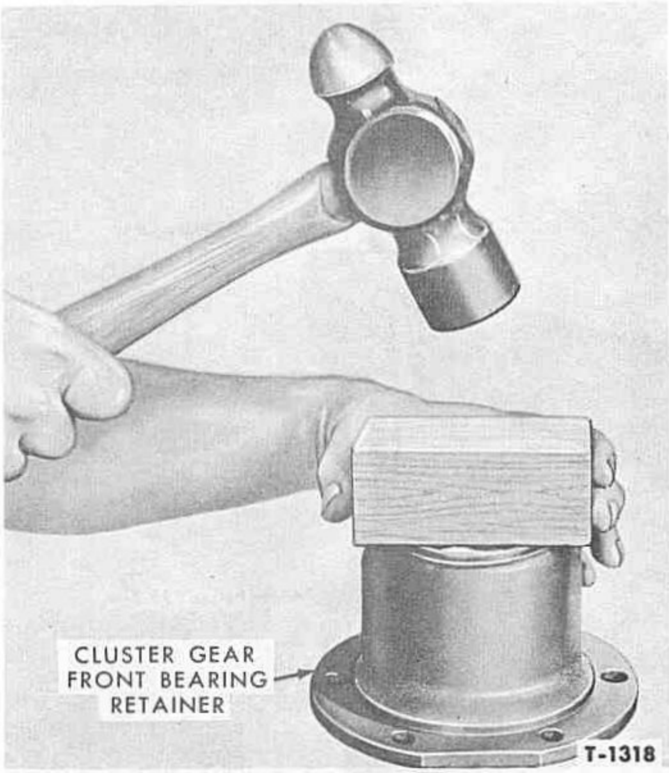


Figure 17—Installing Bearing Cup in Cluster Gear Front Bearing Retainer

Main Cluster Gear:

1. Remove the front and rear bearings with Pullers 951 and 1002 as shown in Figure 20.
2. Press the rear bearing onto the main cluster gear with Step Plate 630-7 as shown in Figure 21. Install the front bearing in the same manner with a 1½″ I.D. sleeve.

Output Gear:

1. Use the access holes behind the inner bearing race in the transmission output gear and drive the bearing off the gear with a hammer and punch.
2. Press a new bearing onto the rear side of the transmission output gear using a 2½″ I.D. sleeve.

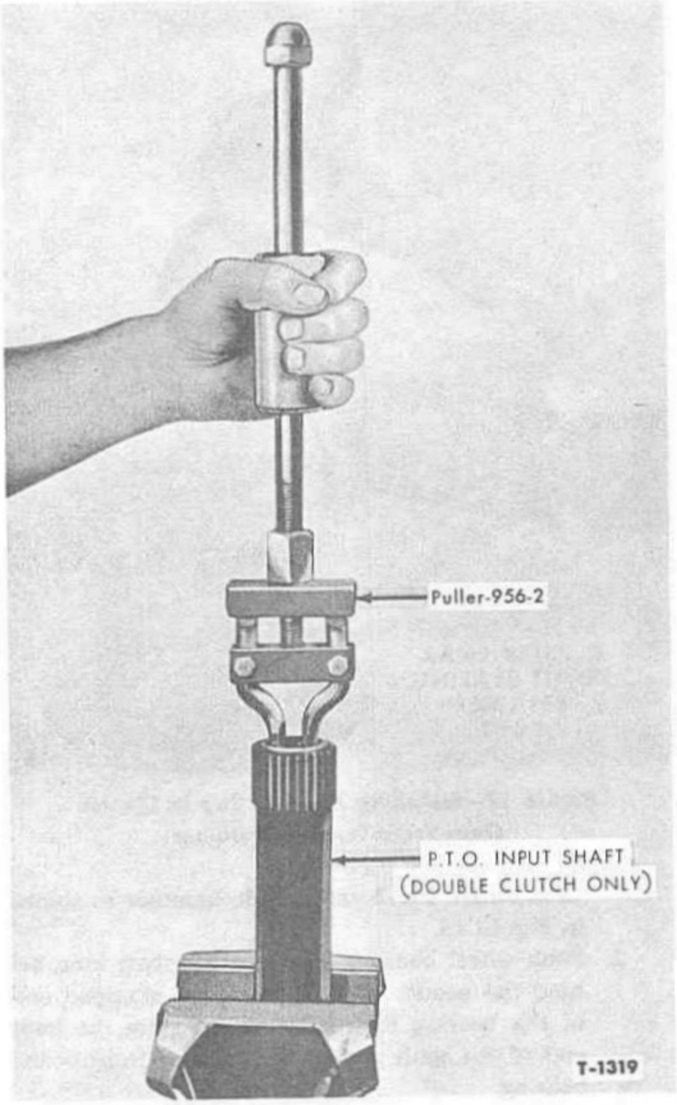


Figure 18—Removing P.T.O. Input Shaft Oil Seal and Needle Bearing

Output Shaft Bearing Retainer:

1. Remove the roller bearing using a punch and hammer, Figure 22.
2. Drive out the oil seal and bearing cup.
3. Coat the wiping surface of the new oil seal with Lubriplate or equivalent and press the seal into the retainer with Step Plate 630-9, Figure 23.
4. Drive or press the bearing into place with Step Plate 630-16. Install the bearing cup with a press or hammer and wood block.

Countershaft Front Bearing Retainer:

1. Remove the bearing cup from the countershaft front bearing retainer with Puller 956 and a slide hammer. Remove the bushing with a hammer and chisel.
2. Install a new bushing in the countershaft front bearing retainer with Bushing Driver Set T-818, Figure 24. Ream the bushing so there is a 0.003" to 0.005" clearance for the shaft portion of the P.T.O. countershaft gear.

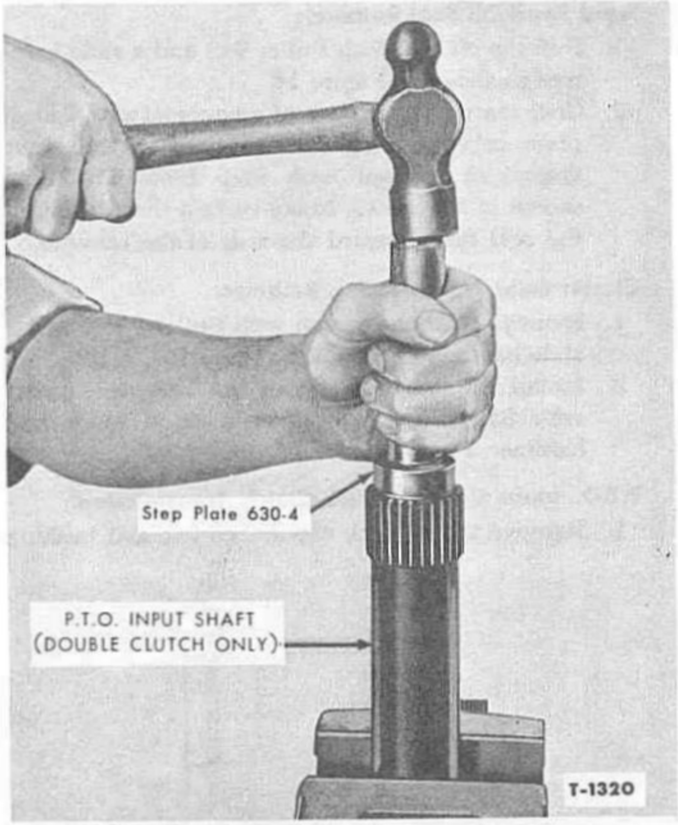


Figure 19—Installing Seal in P.T.O. Input Shaft

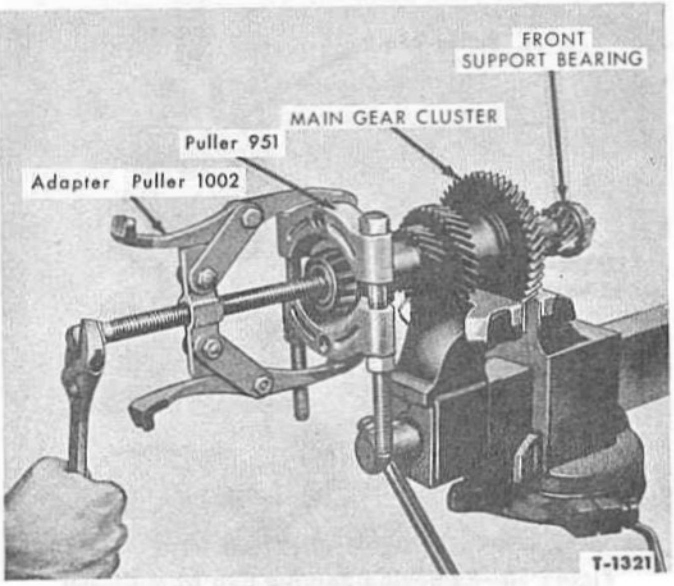


Figure 20—Removing Main Cluster Gear Bearings

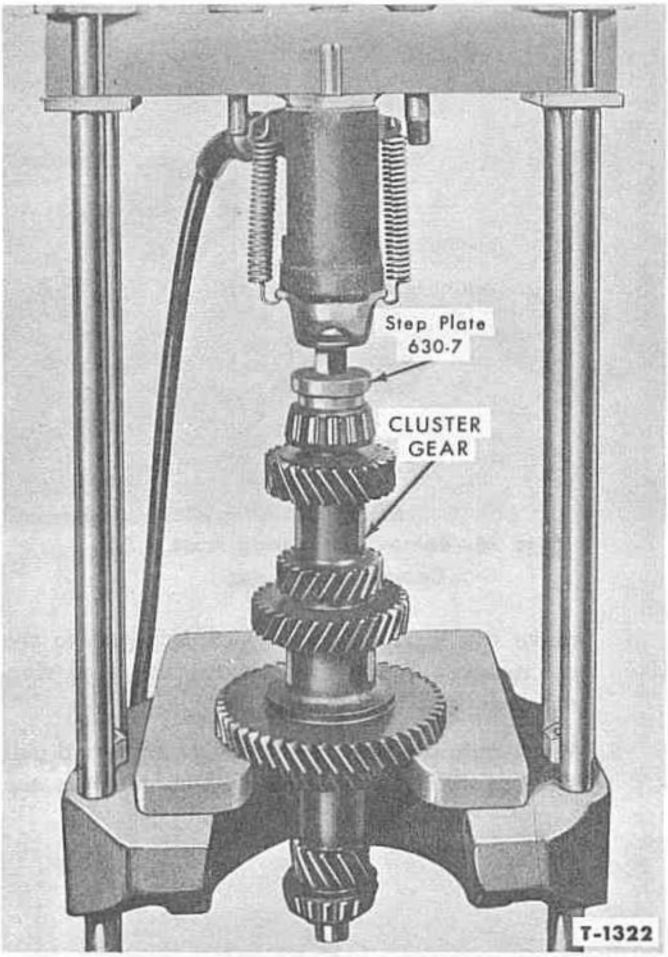


Figure 21—Installing Main Cluster Gear Rear Bearing

3. Install the bearing cup in the retainer with Step Plate 630-15 or a wood block and hammer, Figure 25.

Countershaft P.T.O. Gear:

1. Remove the bearing from the front of the P.T.O. countershaft gear with a punch and hammer through the holes in the gear, Figure 26. Remove the bearing cup with Puller 943 and a slide hammer.
2. Install the bearing cup in the P.T.O. countershaft gear with Step Plate 630-15 or a wood block, Figure 27. Install the bearing on the front of the gear with a 1⅝″ I.D. sleeve and press.

Countershaft: Refer to Figure 28 while working on the countershaft.

1. Work from the rear of the countershaft and remove the bearing with Puller 1002, Bearing Pulling Attachment 951, and Step Plate 630-4. Remove the snap ring, retainer, thrust washer, and 3rd gear. Remove the sliding coupling, connector, and the countershaft reverse gear. Re-

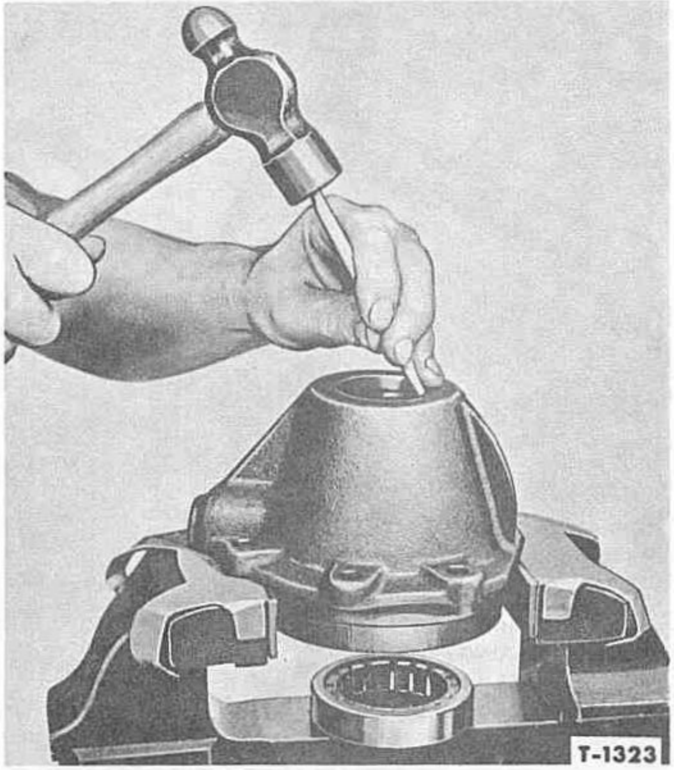


Figure 22—Removing Roller Bearing

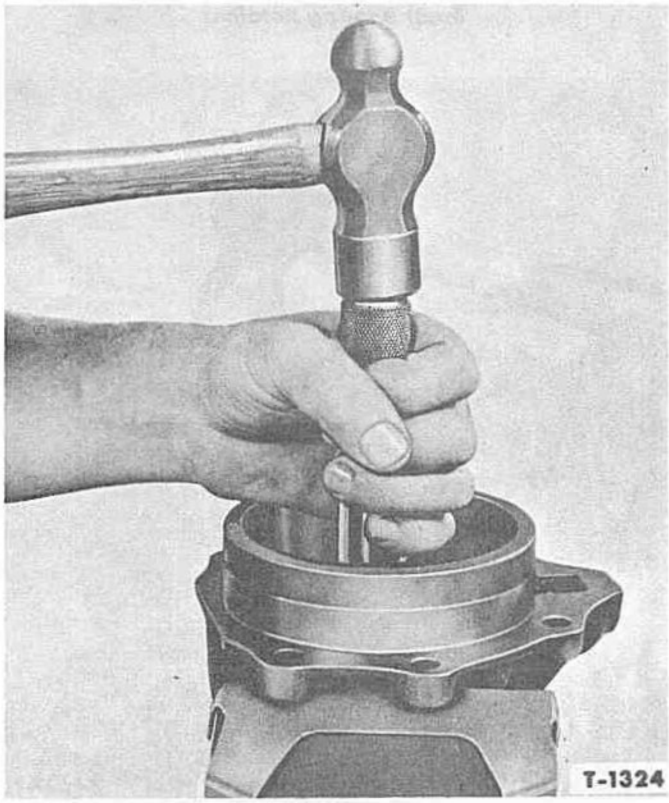


Figure 23—Installing Oil Seal in Output Shaft Bearing Retainer

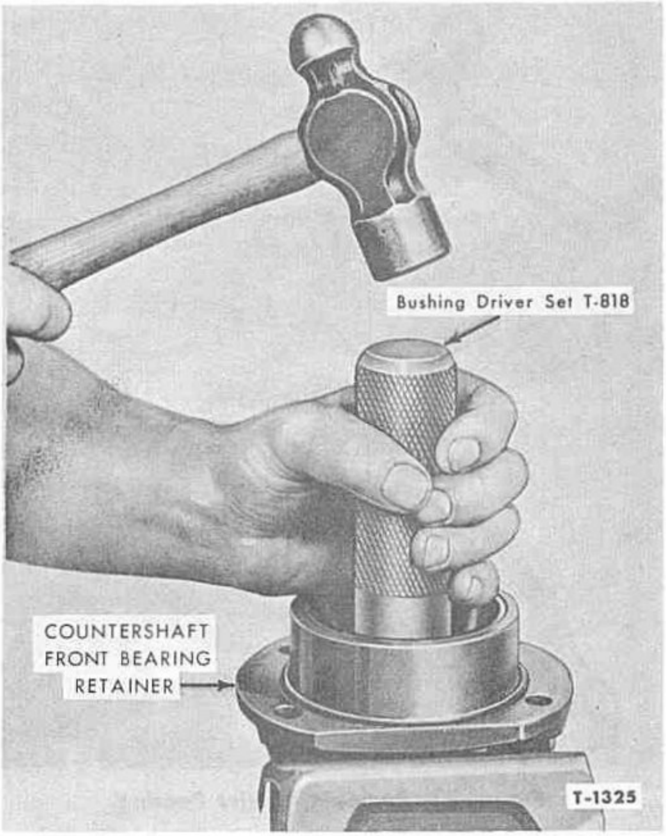


Figure 24—Installing Bushing in Countershaft Front Bearing Retainer

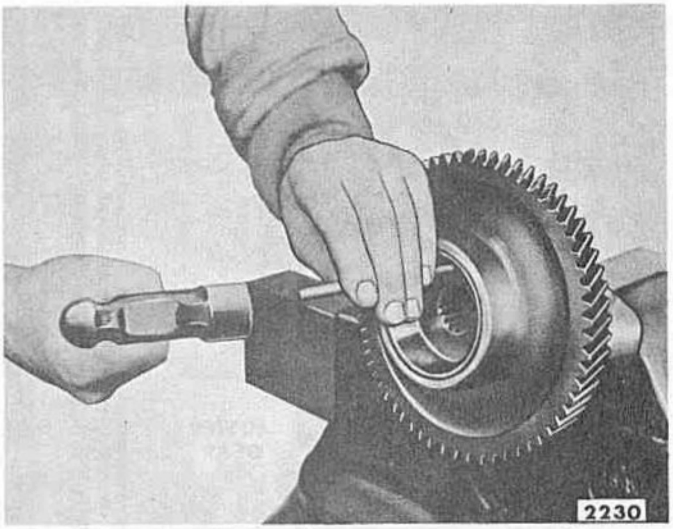


Figure 26—Removing Bearing from P.T.O. Countershaft Gear

move the thrust washer which is keyed to the countershaft spline and remove the snap ring, 4th gear, and sliding coupling.

2. Work from the front of the countershaft and pull the countershaft 1st gear (which removes the

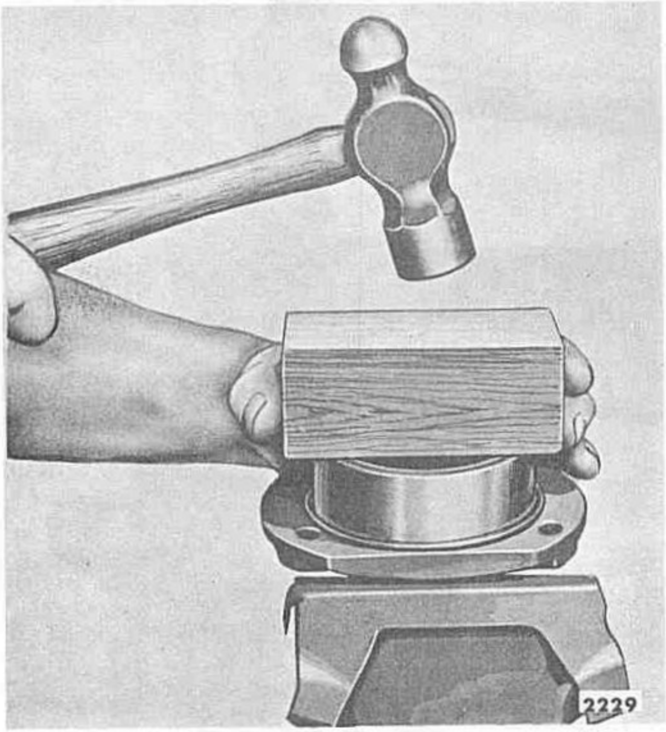


Figure 25—Installing Bearing Cup in Countershaft Front Bearing Retainer

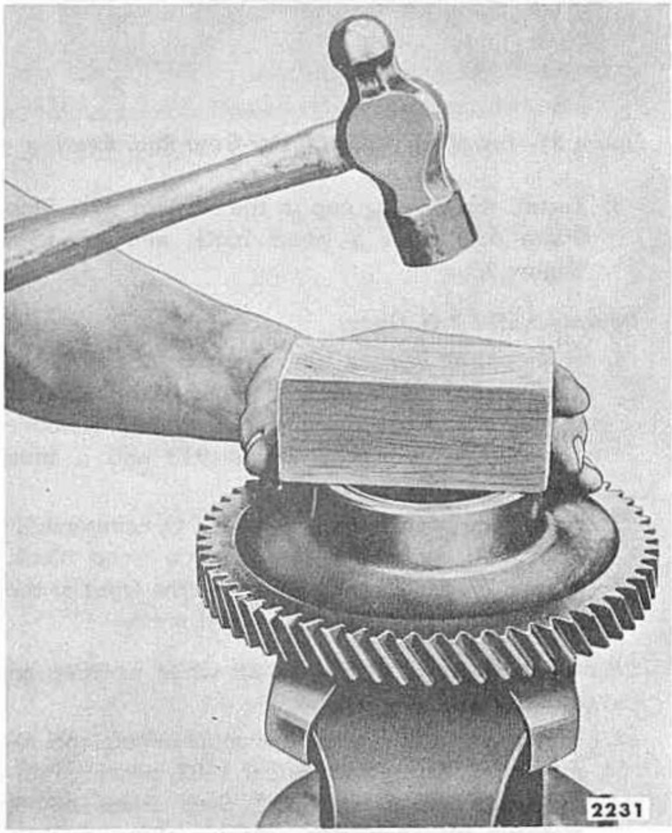


Figure 27—Installing Bearing Cup in P.T.O. Countershaft Gear

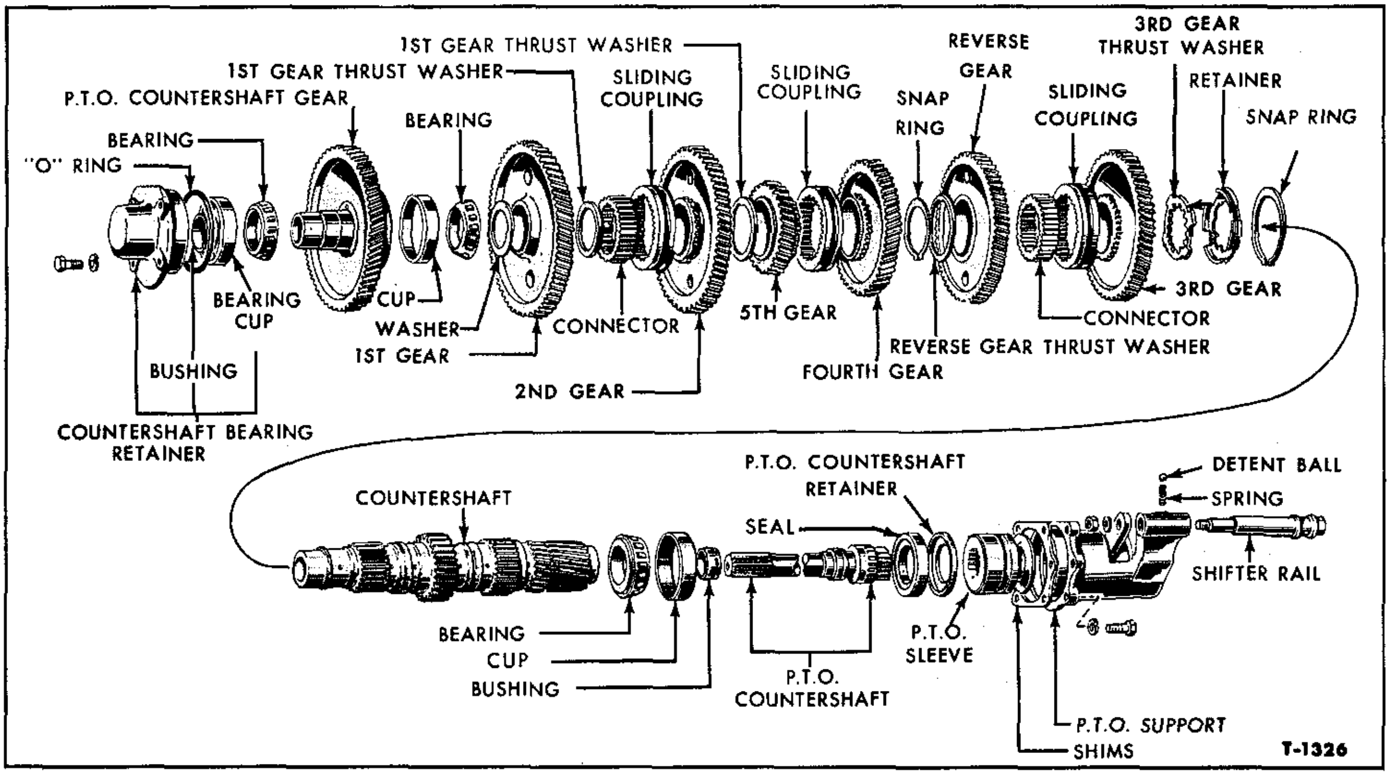


Figure 28—Countershaft Disassembled

bearing and thrust washer) with Puller 1003 and Step Plate 630-4. Remove the thrust washer, sliding coupling, connector and 2nd gear. Remove the keyed thrust washer and 5th gear.

3. Work from the front of the countershaft and slide the 5th speed gear on the countershaft making certain that the spur teeth face toward the rear of the shaft. Install the 2nd gear thrust washer with the locking tab on the shaft next to the 5th speed gear. Slide the 2nd speed gear onto the shaft with the spur teeth facing toward the front. Install the connector then the thrust washer that seats in the connector. Install a sliding coupling on the connector. Install the 1st speed gear and retaining washer. Carefully install the tapered roller bearing on the shaft with Step Plate 630-11.

4. Work from the rear of the shaft and install a sliding coupling on the 5th speed gear. Slip the 4th speed gear onto the shaft with the spur teeth toward the sliding coupling and secure with the snap ring, Figure 28. Install the thrust washer with the locking tab on the shaft next to the snap ring. Slip the reverse gear onto the shaft with the spur teeth facing toward the rear, then install a connector and the sliding coupling (the small notches machined in one end of the connector crown must be positioned next to the 3rd gear). Slip the 3rd speed gear onto the shaft making sure that the spur teeth are toward the front. Install the 3rd gear thrust washer, retainer, and snap ring on the shaft. Install the rear bearing with Step Plate 630-11.

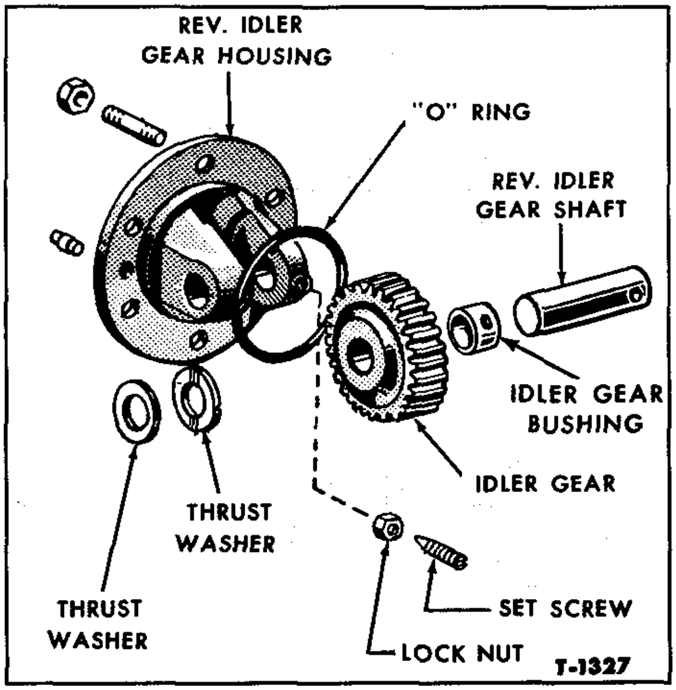


Figure 29—Reverse Idler Gear

P.T.O. Support:

1. Remove the bearing cup from the P.T.O. support, Figure 28, with Puller 943 and a slide hammer. Remove the P.T.O. shifter stop, shifter rail, detent ball, and spring. Remove the P.T.O. shifter sleeve from the rear of the support. Work from the rear of the support and drive out the retainer and oil seal.
2. Install the retainer in the P.T.O. support with a punch and hammer. Coat a new seal with Lubriplate or equivalent and drive it into the front of the support with Step Plate 630-9. Make sure the lip of the seal faces toward the front of the support. Drive the bearing cup into place with Step Plate 630-15.
3. Slide the P.T.O. sleeve into place, Figure 28. Place the spring and detent ball in the support. Hold the ball down with a screwdriver and slide the shifter rail in far enough to cover the detent ball. Place the stop in position in the sleeve groove, then slide the rail forward into the hole in the stop. Secure the rail and stop with a lock washer and nut, Figure 28.

Reverse Idler Gear:

1. Loosen the lock nut and remove the set screw that holds the shaft in the reverse idler gear housing, Figure 29. Remove the shaft, the gear, and the two washers. Remove the bushing from the gear with a hammer and punch.
2. Install a new bushing in the reverse idler gear with Bushing Driver Set 818. Ream the bushing so there is 0.003″ to 0.005″ clearance for the shaft.
3. Position the two thrust washers, thick washers next to gear, on the front (short hub) side of the idler gear. Hold the gear and washers in place in the housing, and install the shaft, Figure 29. Secure the shaft with a set screw and lock nut.

C. Assembly

Always use new gaskets and "O" rings when assembling a transmission. Also make certain that all gears, bearings, and moving parts are lubricated with transmission lubricant.

1. Position the P.T.O. countershaft front bearing retainer and "O" ring seal on the transmission, Figure 28, and tighten the bolts to 20-25 ft. lbs. torque.
2. Position the P.T.O. countershaft gear assembly into the front bearing retainer.
3. Place the assembled countershaft in the transmission case, rear end first. Move the countershaft forward to seat the front countershaft bearing in the P.T.O. countershaft gear bearing cup, Figure 28.

   NOTE: ***Do not insert the P.T.O. countershaft through the rear of the transmission and countershaft until the countershaft preload is established.***
4. Install the P.T.O. countershaft rear support with the original shim pack and torque the bolts to 25-30 ft. lbs. Rap the support a few times with a "soft head" hammer to seat the countershaft bearings.
5. Wrap a piece of cord around the countershaft final drive, Figure 11. Attach the other end of the cord to Pull Scale 3600-E. Pull the scale and at the same time note the reading. The scale should read 6-8 pounds pull. If necessary, remove shims to increase the preload or add shims to decrease the preload. Shims are available in 0.003″, 0.005″, and 0.012″ thicknesses.

   NOTE: ***If the countershaft has all new bearings establish a preload of 14-16 pounds pull.***
6. Install the shifter shaft, seat, gasket, spring, and plunger. Place the interlock in position, flat side of the hinge toward the case, and install the hinge rod, Figure 12.
7. Position the shifter fork and gate on the 4th and 5th gear coupling, then install the bottom rail

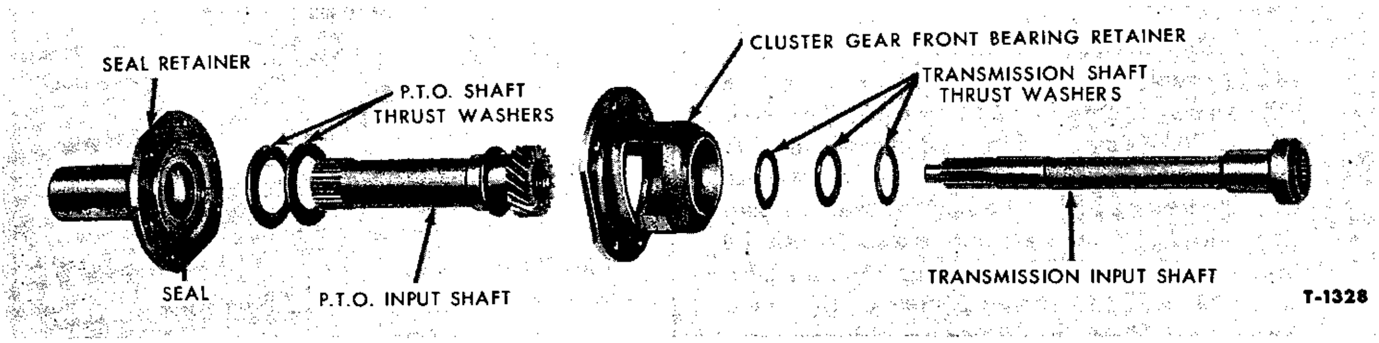

SEAL RETAINER
P.T.O. SHAFT THRUST WASHERS
CLUSTER GEAR FRONT BEARING RETAINER
TRANSMISSION SHAFT THRUST WASHERS
SEAL
P.T.O. INPUT SHAFT
TRANSMISSION INPUT SHAFT
T-1328

Figure 30—Input Shafts and Retainer for Double Clutch Transmission

through the bottom expansion plug hole. Slide the rail through the fork. Turn the set screw all the way in and tighten the lock nut. All sliding couplings should be in the neutral position; then the plunger hole in the rail should line up with the plunger seat hole in the side of the case. Install the plunger, spring, gasket, and plug for the bottom rail.

8. Position the shifter fork on the coupling for the 1st and 2nd gears. Position the middle rail gate in the interlock and slide the middle rail through the gate and fork. Install the two set screws, tighten them securely, and install the lock nuts. Install the middle rail shift detent plunger, spring, gasket, and seat.
9. Remove the P.T.O. support so the countershaft assembly will lower slightly.
10. Install the transmission output gear, Figure 13.
11. Install the shifter fork on the 3rd and reverse gear coupling. Slide the top rail through the fork and the gate, then position the gate in the interlock, Figure 12, and install the set screws with locking nuts. Install the shift rail detent plunger, spring, gasket, and seat. Be sure the plunger enters the middle hole in the rail.
12. Install new expansion plugs at the end of each shift rail. Install the P.T.O. support (leave the countershaft out) and tighten the bolts to 25-30 ft. lbs. torque.
13. Install the main cluster gear, front end first.
14. Install the output shaft bearing retainer.
15. Install the main cluster gear front bearing retainer and gasket.
16. Install the transmission input shaft and thrust washer.

Double Clutch Transmission: Install three input shaft thrust washers, the P.T.O. input shaft, and two P.T.O. shaft thrust washers, Figure 30. Position the two outside input shaft washers so their oil grooves are against the middle washer. The middle washer has oil grooves on both sides.

17. Install the oil seal retainer and gasket. Tighten the nuts to 25-30 ft. lbs. torque.
18. Check to see that all gears move freely and that the shifter forks can be moved forward and backward with a large screwdriver.
19. Install the reverse idler gear housing assembly and "O" ring on the right side of the transmission case. Tighten the attaching nuts to 40-50 ft. lbs. torque.
20. Position the forks in neutral and check the main cluster gear preload as shown in Figure 31. With the cord wrapped around the main cluster gear (between gears), establish a pull of 8-10 lbs. on the double clutch transmission. Preload can be adjusted by varying the quantity or thickness of shims used on the rear bearing retainer. Shims are available in 0.003", 0.005", and 0.012" thicknesses.

NOTE: ***The input shaft in single clutch transmissions turns the P.T.O. gear, which was preloaded with the countershaft. To obtain an equivalent main cluster gear preload on single clutch transmissions, the pull scale must read 10-12 lbs.***

21. Install the P.T.O. countershaft and the transmission cover assembly.
22. Install the Woodruff key and spring at the top of the shifter shaft. Install the shift lever, making sure the slot on the shift lever engages the Woodruff key. Install the flat washer, lock washer, and retaining nut and tighten the nut securely.
23. Inspect the clutch release shaft bushings, and on some model tractors, the brake shaft bushings. If necessary, remove the bushings and install new ones using Bushing Driver Set 818. Ream the bushings so there is a 0.003" to 0.005" clearance on the shaft.
24. Install the clutch release shaft, fork, spring, bolt, and lock nut. Make sure the offset end of the spring is positioned toward the transmission case.
25. Install the clutch throwout bearing and hub assembly. The word "top" is cast in the hub for proper positioning. Seat the spring in the bearing hub and on the stop in the transmission case.

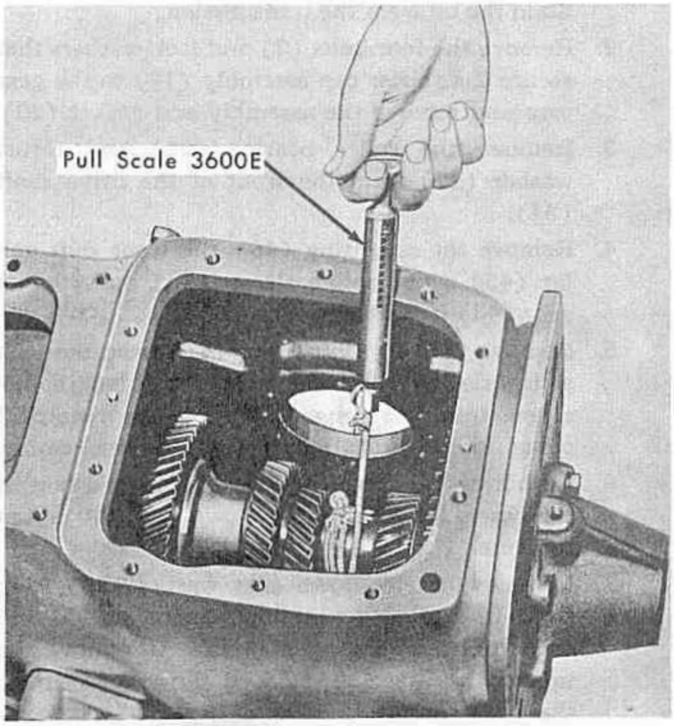


Figure 31—Checking the Main Shaft Preload

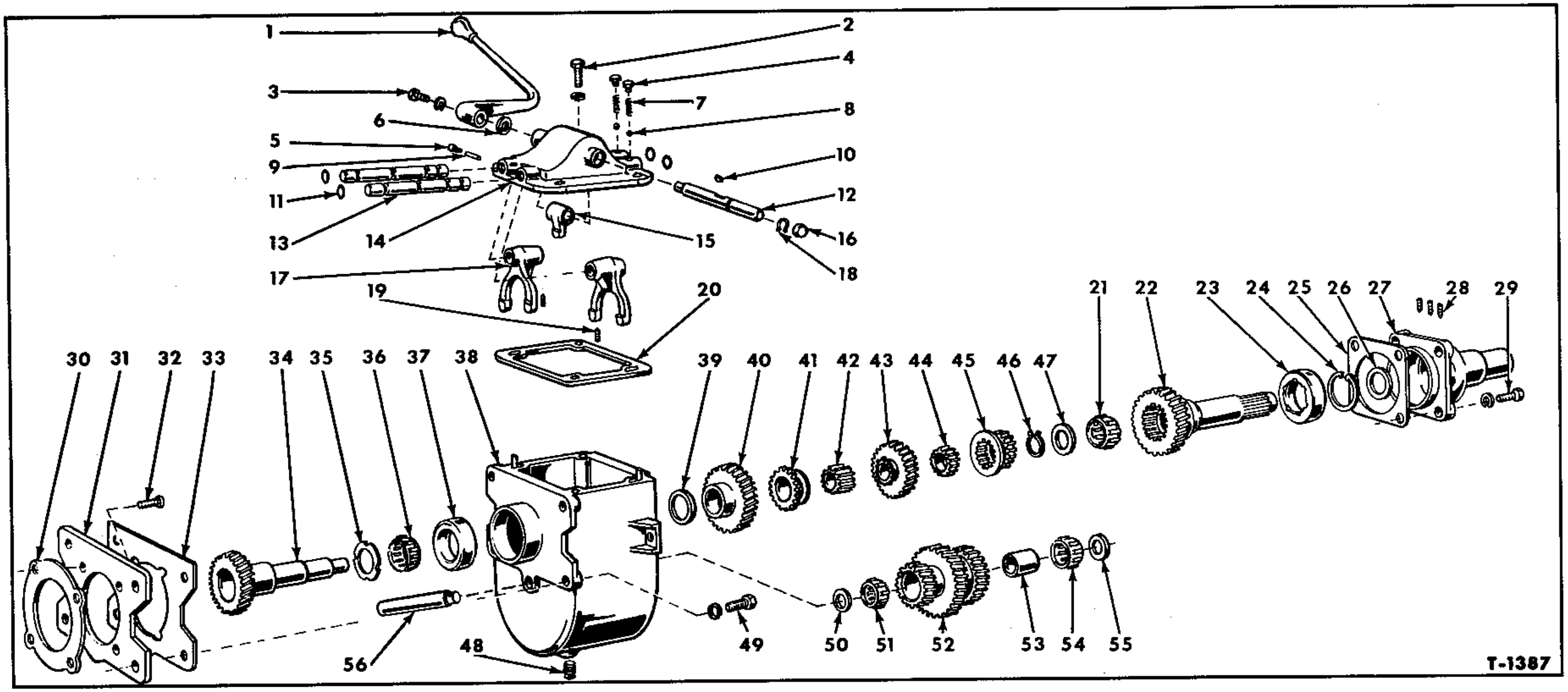
5. SHERMAN STEP-UP AND STEP-DOWN TRANSMISSION

A. Removal

1. Separate the tractor as outlined on Page 168.
2. Disconnect the clutch release bearing springs and remove the clutch release bearing and hub assembly.
3. Remove the four bolts (29), Figure 32, and lock washers that secure the clutch shaft support and clutch shaft assemblies to the front of the Sherman Transmission. Separate these assemblies from the gear case and remove the gasket (25) from the support housing.
4. Remove the Allen head bolt (3) and lock washer from the Sherman Transmission hand shift rod (1) and remove the shift rod from the transmission.
5. Remove the four bolts (49) and lock washers that secure the Sherman Transmission to the mounting flange. Withdraw the transmission assembly from the tractor transmission case.
6. Remove the four Allen head bolts (32 that secure the mounting flange to the tractor transmission and withdraw the flange (31) and shims (30) from the housing.

B. Disassembly

1. Remove the magnetic drain plug (48), Figure 32, from the bottom of the gear case (38) and drain the oil from the transmission.
2. Remove the four bolts (2) and lock washers that secure the shifter cap assembly (14) to the gear case and remove the assembly and gasket (20).
3. Remove the roller bearing (21) and thrust washer (47) from the front of the drive shaft (34).
4. Remove the snap ring (46), the front shift collar (45), short spline sleeve (44) and step-up gear (43) from the drive shaft.
5. Remove the rear shift collar (41) from the long spline sleeve (42) and remove the long spline sleeve from the drive shaft. Tag the rear shift collar for identification to facilitate reassembly.
6. Withdraw the drive shaft (34) from the rear of the case, then lift the step-down gear (40) from the case.
7. Remove the step-down gear washer (39) from shaft. Using Bearing Pulling Attachment 951 and arbor press, as shown in Figure 33, remove the tapered bearing (36) and oil slinger (35) from the drive shaft.
8. Drive the cluster shaft (56), Figure 32, toward the rear end of the gear case with a suitable driver.
9. Hold the cluster gear (52) while withdrawing the cluster gear shaft and remove the gear and two thrust washers (50 and 55) from the gear case.
10. Remove the two roller bearings (51 and 54) and bearing spacer (53) located in the bore of the cluster gear.
11. Remove the three socket set screws (28) from the pilot diameter of the front support housing (27) and remove the clutch shaft assembly from the front support.
12. Remove the snap ring (24) that secures the ball bearing (23) to the clutch shaft (22).
13. With Bearing Pulling Attachment 951 and arbor press, remove the ball bearing (23) from the clutch shaft as shown in Figure 34.
14. Remove the main oil seal (26), Figure 32, from the support housing (27) with Puller 956-2 and a slide hammer.
15. Remove the two detent caps (4), detent springs (7), and detent balls (8) from the shifter cap assembly.
16. Remove the lock wire securing the drilled head set screws (19) to the shifter fingers (17) and then remove the set screw from each finger.
17. Remove the Welch plugs (11) from the shifter rod bores at the rear end of the shifter cap. The rear end is the end opposite the detent balls.
18. Drive the shifter rods (13) and Welch plugs (11) out the front of shifter cap (14) and remove the shifter fingers (17). The shifter fingers and shifter rods are indentical and completely interchangeable.
19. Remove the socket set screw (5) located in the side of the shifter cap and remove the interlock (9).
20. Remove the snap ring (18) from the groove in the selector shaft (12). Slide snap ring and selector fork (15) off the end of the shaft. Remove the Woodruff key (10) from selector shaft and draw the shaft out of its bore.
21. Remove the shifter cap seal (6) from the selector shaft bore.
22. Place the gear case on the bed of an arbor press, with the rear end of the case facing down. Position Step Plate 630-11 on the wide shoulder of the tapered bearing cup. Bring the ram of press down on the step plate and remove the bearing cup (37) from the gear case.



1. Hand Shift Rod
2. Shifter Cap Retaining Bolt
3. Allen Head Bolt
4. Detent Cap
5. Set Screw
6. Seal
7. Detent Spring
8. Detent Ball
9. Interlock
10. Woodruff Key
11. Welch Plug
12. Selector Shaft
13. Shifter Rod
14. Shifter Cap
15. Selector Fork
16. Welch Plug
17. Shifter Finger
18. Snap Ring
19. Set Screw
20. Shifter Cap Gasket
21. Roller Bearing
22. Clutch Shaft
23. Ball Bearing
24. Snap Ring
25. Support Housing Gasket
26. Main Oil Seal
27. Support Housing
28. Set Screw
29. Support Housing Retaining Bolt
30. Shim
31. Mounting Flange
32. Mounting Flange Retaining Bolt
33. Flange Gasket
34. Drive Shaft
35. Oil Slinger
36. Tapered Bearing
37. Bearing Cup
38. Gear Case
39. Step-Down Gear Washer
40. Step-Down Gear
41. Shift Collar (rear)
42. Spline Sleeve (long)
43. Step-Up Gear
44. Spline Sleeve (short)
45. Shift Collar (front)
46. Snap Ring
47. Thrust Washer
48. Drain Plug
49. Gear Case Retaining Bolt
50. Thrust Washer
51. Roller Bearing
52. Cluster Gear
53. Bearing Spacer
54. Roller Bearing
55. Thrust Washer
56. Cluster Shaft

Figure 32—Step-Up and Step-Down Transmission—Disassembled

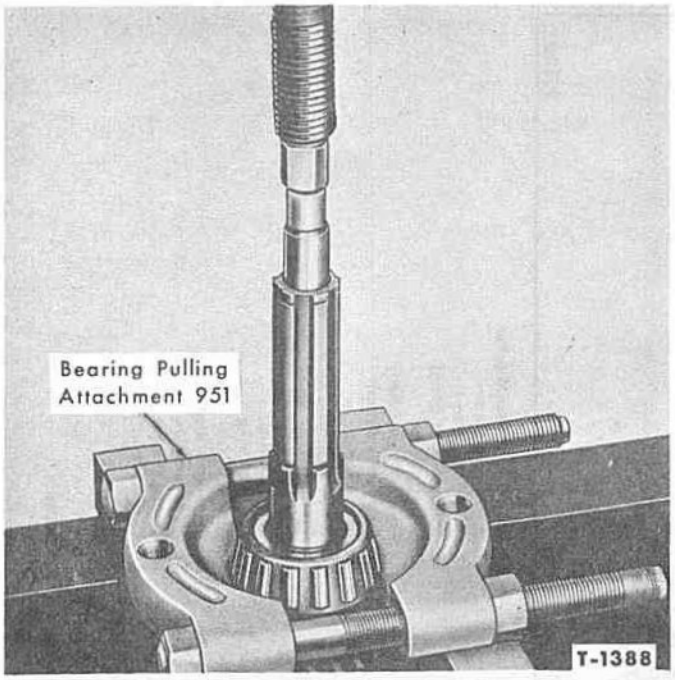


Figure 33—Removing Tapered Bearing from Drive Gear

C. Inspection

1. Clean all parts with a solvent.
2. Inspect the clutch shaft ball bearing for rough spots, freedom of movement and any signs of discoloration or wear. Replace the bearing if necessary.
3. Inspect the drive shaft tapered bearing and bearing cup for flat spots, freedom of movement and any signs of wear. Replace the bearing and cup if necessary.
4. Inspect all drive shaft gears for erratic wear patterns, damaged teeth, signs of cupping, overheating on gear end faces, or scoring on the inside diameters. Replace as required.
5. Inspect the cluster shaft, cluster gear and the roller bearing as follows:
   a. Inspect the inside diameter of the cluster gear for signs of wear. Check gear teeth for signs of damage. Inspect end faces for cupping or signs of overheating.
   b. Inspect the roller bearings for flat spots, freedom of movement and other signs of wear.
   c. Inspect the cluster shaft for scoring, pitting and wear.
   d. If wear or damage is found in any of the above parts, replace the cluster shaft, cluster gear and bearings as an assembly.
6. Install the shifter rods and selector shaft in the bores of the shifter cap and check for freedom of movement. If the shaft or rods bind, check to see if they are bent. If bent, replace. If binding occurs due to scoring, clean the rods and shaft with crocus cloth to eliminate the bind.
7. Inspect the shifter fingers and the selector fork for signs of shifter collar contact at points other than at finger pads. If the collar has been contacting the fingers of fork at points other than at the fingerpads, replace the shifter finger or shifter fork assemblies.
8. Inspect the interlock for flat spots or signs of scoring. Replace if necessary.
9. Replace all gaskets, thrust washers, oil seals and Welch plugs.

D. Assembly

1. Place the gear case (38), Figure 32, on the bed of an arbor press with the rear end of the case facing up. Position the bearing cup (37) in the gear case with the wide shoulder of the cup facing down. Place Step Plate 630-13 on narrow shoulder of cup, bring ram of press down on plate and press the cup into the case until it bottoms on the seat.
2. Install a new seal (6) in the selector shaft bore in the shifter cap. Use a step plate or suitable installer. Start the selector shaft (12) in its bore

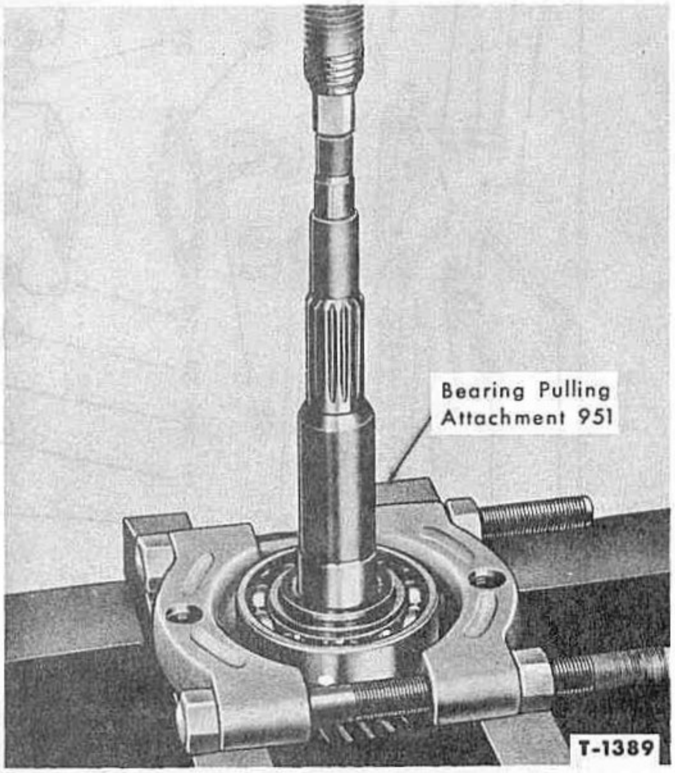


Figure 34—Removing Clutch Shaft Bearing

and place the selector fork (15) and snap ring (18) on the shaft. Insert Woodruff key (10) in its groove and slide the fork on the shaft until key engages the keyway in the fork. Then position the snap ring in the groove in the shaft.

3. Start the shifter rod (13) in the bore farthest from the interlock plug location and with the two grooves toward the detent end of the shifter cap. Position a shifter finger (17) on the rod so that the selector fork engages in the recess in the shifter finger. Align the tapped hole in the shifter finger with the center groove in rod and secure the finger to shaft with a drilled head set screw (19).
4. Place the interlock (9) in its bore and install the interlock set screws (5).
5. Start the other shifter rod in its bore and install the shifter finger as in step 3. Secure set screws with lock wire.
6. Place detent balls (8) in their bores. Place a detent spring (7) on top of each ball and install the detent caps (4).
7. Install new Welch plugs (11) in the ends of each shifter rod bore.
8. Install a new main oil seal (36) in the support housing.
9. Install the ball bearing (23) on the clutch shaft (22) with a step plate, an arbor press and hollow sleeve, as shown in Figure 35. Install the snap ring (24), Figure 32, in groove in shaft.
10. Insert the clutch shaft and bearing assembly in the front support (27) and install the three socket set screws (28).
11. Insert the bearing spacer (53) in the bore of the cluster gear (52) and place roller bearings (51 and 54) at each end of the spacer.
12. Start the cluster shaft (56), small end first, into its bore at the rear of the case. Place the rear thrust washer (50) on the shaft. Position the cluster gear (52) in the gear case with the larger end gear facing the front of gear case. Insert the shaft through the gear cluster and place the front thrust washer (55) on the end of the shaft. Then, tap the cluster shaft until the pilot seats in the bore at the front end of the gear case.
13. Place a new oil slinger (35) on the drive shaft (34) and install a new tapered bearing (36) on the shaft, as shown in Figure 36. Place a new step-down gear washer (39) next to the bearing.
14. Position the drive shaft assembly in the gear case and assemble the parts of the drive shaft in the following order:
    - a. The step-down gear (40), Figure 32, with hub toward the gear end of shaft.
    - b. The long spline sleeve (42).
    - c. The rear shift collar (41) with engaging teeth positioned toward the step-down gear.
    - d. The step-up gear (43) with shift collar engaging teeth toward the gear end of the shaft.
    - e. The short spline sleeve (44).

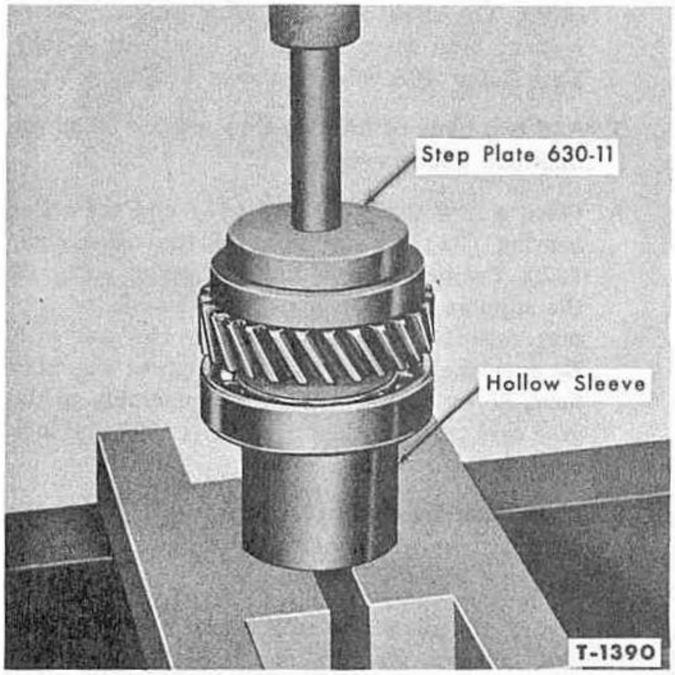


Figure 35—Installing Clutch Shaft Bearing

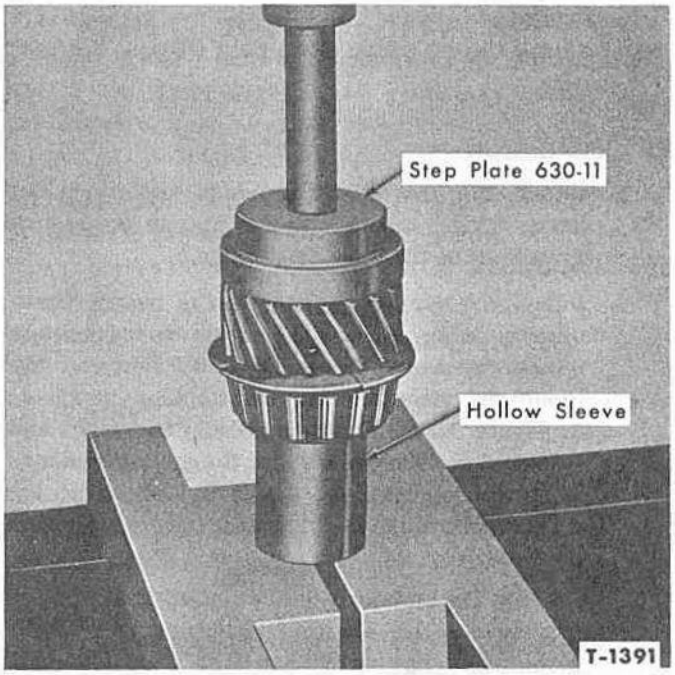


Figure 36—Installing Tapered Bearing on Drive Shaft

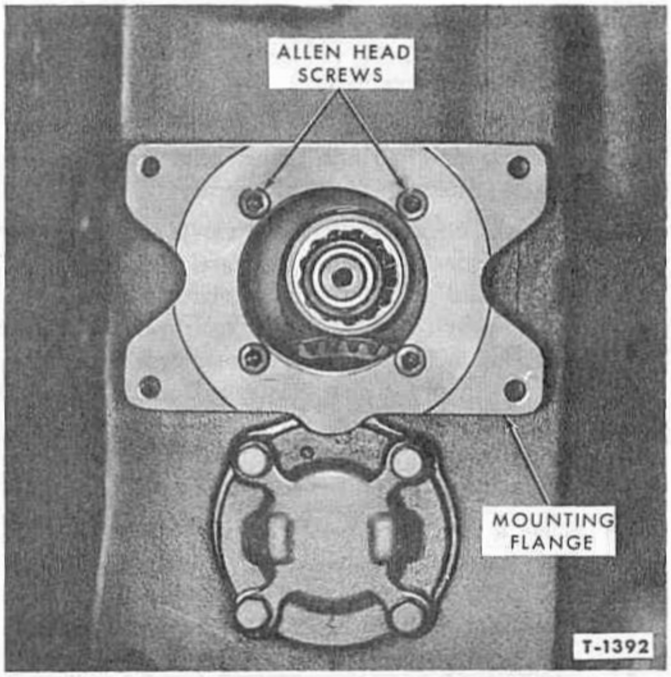


Figure 37—Mounting Flange Installed in Tractor Transmission Case

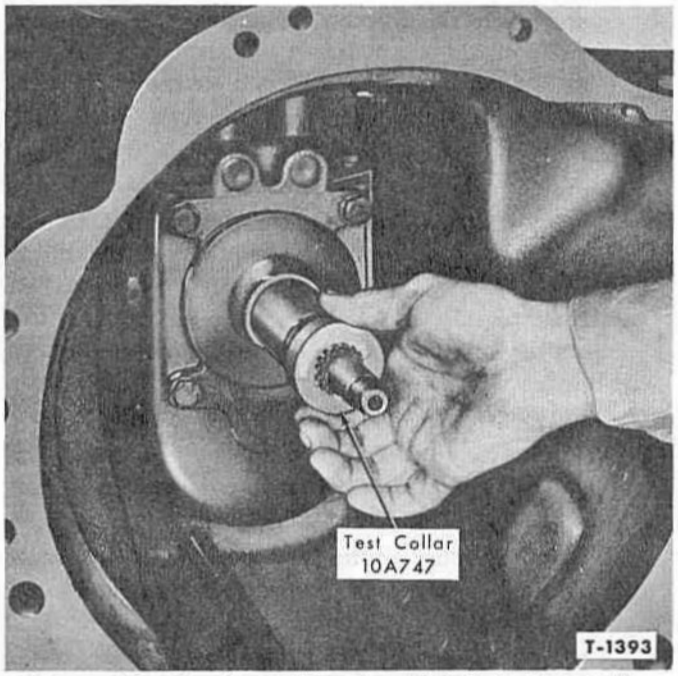


Figure 38—Checking Shimming with Shim Test Collar

f. The front shift collar (45) with the engaging teeth toward the front of the gear case.

g. Install the snap ring (46).

15. Position a new shifter cap gasket (20) on top of the gear case assembly. Place the shifter cap assembly on the case, making sure that the shifter fingers engage with the shift collars. Secure the cap to the case with four bolts (2) and lock washers.

16. Install the magnetic drain plug (48) in the gear case.

E. Installation

1. Check the tractor transmission case face for burrs which might prevent proper seating or alignment of the mounting flange.

2. Install the mounting flange in the tractor transmission case, Figure 37, with approximately 0.050″ thickness of shims (30) between the mounting flange and the transmission, as shown in Figure 32. Shims are available in 0.007″ and 0.012″ sizes. The flat edge of the mounting flange is at the top and the flange is secured to the tractor transmission with the four Allen head bolts (32).

3. Position the mounting flange gasket (33) in place and secure the Sherman Transmission to the mounting flange with four bolts (49) and lock washers.

4. Check the drive shaft of the Sherman Transmission for end play by turning the drive shaft by hand. If any end play exists, remove one or more shims from between the flange and the tractor transmission. Repeat this operation until end play is eliminated.

5. After end play has been removed, the Sherman Transmission should be preloaded by removing approximately 0.005″ to 0.007″ thickness of shims. The shaft will then offer snug resistance with no bind when turned by hand with a shim Test Collar 10A747A as shown in Figure 38.

6. Add two pints of SAE 80 transmission oil to the Sherman Transmission.

7. Place a new thrust washer (47) and the roller bearing (21) on the front of the drive shaft (22). Position a new support gasket (25) on the support assembly (27), and install the support assembly and clutch shaft to the gear case. Be sure the drain slot in the support assembly faces down. Secure the support assembly to the gear case with four hex head bolts (29) and lock washers.

8. Install the hand shift rod (1) to the selector shaft with an Allen head bolt (3) and lock washer and check the shifting of the transmission.

9. Install the clutch release bearing and springs and connect the tractor transmission to the tractor.

6. SHERMAN FORWARD AND REVERSE TRANSMISSION

A. Removal

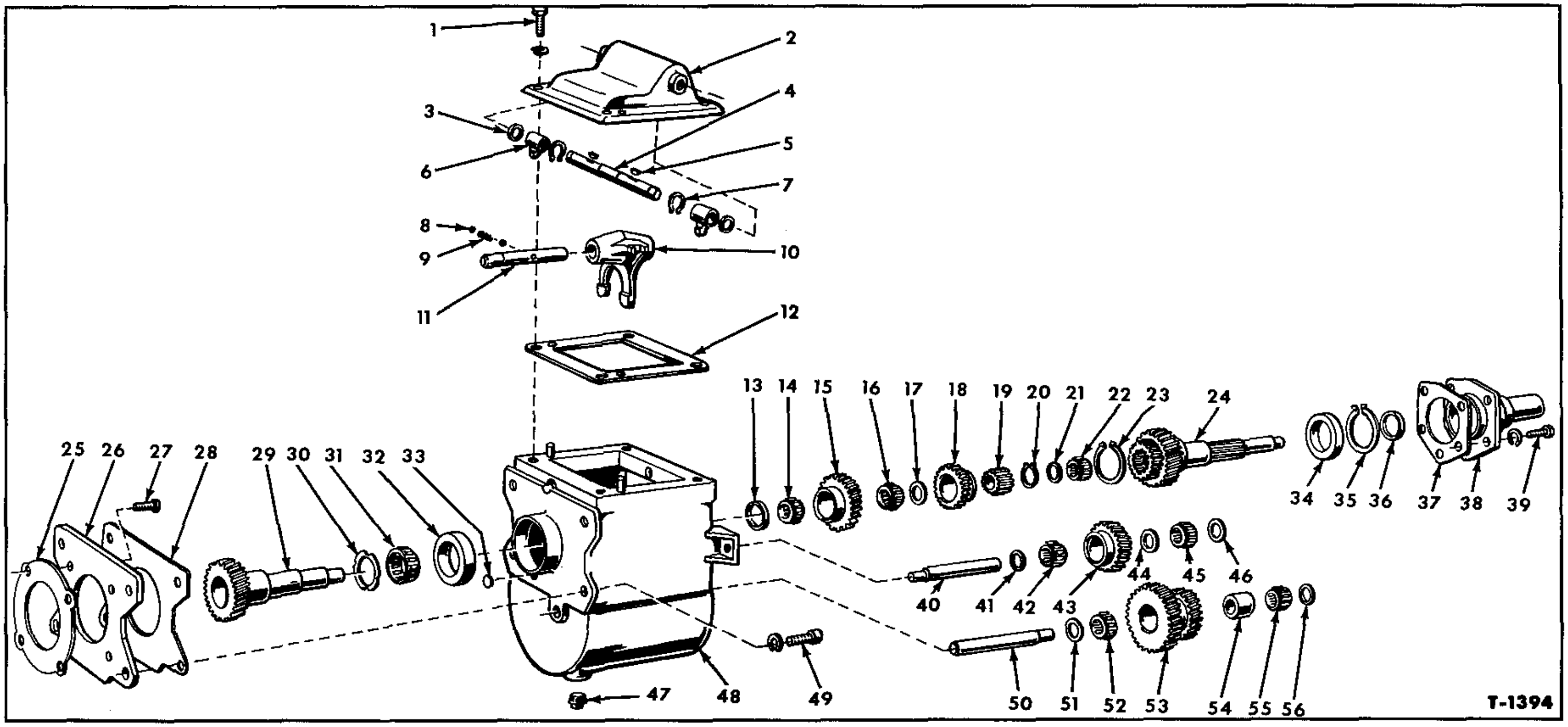
1. Separate the tractor as outlined on Page 168.
2. Disconnect the clutch release bearing springs and remove the clutch release bearing and hub assembly.
3. Remove the five bolts (39), Figure 39, and lock washers that secure the support housing (38) and clutch shaft (24) to the front of the Sherman Transmission gear case. Separate these assemblies from the gear case and remove the gasket (37) from the support housing.
4. With a 5/16" socket and a 5/16" hex key approximately one inch long, remove the four hex head cap screws (49) and washers that retain the Sherman Transmission to the mounting flange (26). Remove the transmission and gasket (28) from the mounting flange (26).
5. Using the same socket and hex key as in step 4, remove the four hex head cap screws (27) that secure the mounting flange to the tractor transmission case. Remove the flange and shim(s) (25).
6. Remove the magnetic drain plug (47) from the bottom of the gear case and drain the oil from the transmission.

B. Disassembly

1. Remove the four bolts (1) and lock washers that retain the shifter cap assembly to the gear case and lift the shifter cap (2) and gasket (12) from the case (48).
2. Remove the two snap rings (7) from the selector shaft (4) and move the selector forks (6) on the shaft to permit removal of the two Woodruff keys (5).
3. Slide the selector shaft out of the selector cap and remove the two selector forks from the cap. Remove the two "O" rings (3) from the selector shaft.
4. Remove the snap ring (23) that retains the clutch shaft assembly in the support assembly. Tap the front end of the shaft with a rubber mallet to remove the shaft assembly from the support housing.
5. Remove the clutch shaft snap ring (35) that retains the clutch shaft ball bearing (34) on the clutch shaft (24).
6. With Bearing Pulling Attachment 951, and arbor press, as shown in Figure 40, remove the clutch shaft ball bearing from the clutch shaft.
7. With Puller 956-2 and a slide hammer, remove the main oil seal (36), Figure 39, from the support housing (38).
8. Working from the rear of the gear case, drive the shifter rail (11) out of the gear case with a brass rod. Lift the shifter finger and sleeve assembly (10) from its position on the shift collar. NOTE: ***There are two small steel balls (8) and a spring (9) located in the shifter rail. Be very careful not to lose them while removing the shifter rail.***
9. Remove the clutch shaft roller bearing (22) and small thrust washer (21) from the front end of the drive gear.
10. Remove the snap ring (20) from the front end of the drive gear and remove the shift collar (18), the spline sleeve (19), the large thrust washer (17), the reverse gear (15), the roller bearings (14 and 16), and the drive gear spacer (13). Withdraw the drive gear (29) assembly from the rear end of the gear case.
11. With Bearing Pulling Attachment 951 and arbor press, remove the tapered bearing (31) from the drive gear (29) as shown in Figure 41.
12. Remove the oil slinger (30), Figure 39, from the drive gear.
13. With a brass rod and a hammer and driving from inside of the gear case, remove the expansion plug (33) located in the rear end of the case.
14. Working through the expansion plug hole with a brass rod and hammer, remove the idler shaft (40) from the gear case. Lift the idler gear (43) and thrust washers (41 and 46) out of the gear case. Remove the two roller bearings (42 and 45) and spacer (44) from the bore in the idler gear.
15. Working from the front of the gear case with brass rod and hammer, remove the cluster shaft (50) from the gear case. Lift the cluster gear (53) and the thrust washers (51 and 56) out of the case. Remove the two roller bearings (52 and 55) and spacer (54) from the bore in the cluster gear.
16. Place the gear case (48) on the bed of an arbor press, with the rear end of the case facing down. Position Step Plate 630-11 on the wide shoulder of the tapered bearing cup (32). Bring the ram of press down on step plate and remove the bearing race from the case.

C. Inspection

1. Clean all parts with a solvent.
2. Inspect the clutch shaft ball bearing for rough spots, freedom of movement and any signs of discoloration or wear. Replace the bearing if necessary.
3. Inspect the drive shaft tapered bearing and bear-



1. Shifter Cap Bolt
2. Shifter Cap
3. "O" Ring, Selector Shaft
4. Selector Shaft
5. Woodruff Key
6. Selector Fork
7. Snap Ring
8. Ball
9. Shift Rail Spring
10. Shifter Finger and Sleeve Assembly
11. Shifter Rail
12. Shifter Cap Gasket
13. Drive Gear Spacer
14. Reverse Gear Roller Bearing
15. Reverse Gear
16. Reverse Gear Roller Bearing
17. Thrust Washer
18. Shift Collar
19. Spline Sleeve
20. Drive Gear Snap Ring
21. Thrust Washer
22. Clutch Shaft Roller Bearing
23. Snap Ring
24. Clutch Shaft
25. Shim
26. Mounting Flange
27. Mounting Flange Retaining Cap Screw
28. Flange Gasket
29. Drive Gear
30. Oil Slinger
31. Tapered Bearing
32. Bearing Cup
33. Expansion Plug
34. Clutch Shaft Bearing
35. Clutch Shaft Snap Ring
36. Main Oil Seal
37. Support Gasket
38. Support Housing
39. Support Housing Retaining Bolt
40. Idler Shaft
41. Thrust Washer
42. Idler Shaft Roller Bearing
43. Idler Gear
44. Idler Gear Spacer
45. Idler Shaft Roller Bearing
46. Thrust Washer
47. Drain Plug
48. Gear Case
49. Gear Case Retaining Cap Screw
50. Cluster Shaft
51. Thrust Washer
52. Cluster Shaft Roller Bearing
53. Cluster Gear
54. Cluster Gear Spacer
55. Cluster Shaft Roller Bearing
56. Thrust Washer

Figure 39—Forward and Reverse Transmission-Disassembled

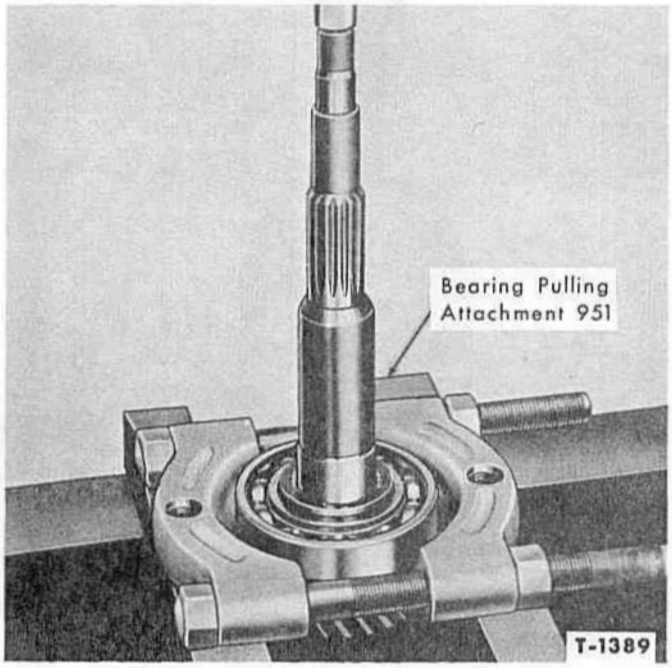


Figure 40—Removing Clutch Shaft Bearing

ing race for rough spots, freedom of movement and any signs of discoloration or wear. Replace the bearing and race if necessary.

4. Inspect all drive shaft gears for erratic wear patterns, damaged teeth, signs of cupping, over-heating on gear end faces, or scoring on the inside diameters. Replace as required.
5. Inspect all roller bearings for flat spots, freedom of movement and other signs of wear. Replace as required.
6. Install the shifter rail in the gear case and check for freedom of movement. If shaft binds, check to see if it is bent. If the shaft is bent, replace it. If binding occurs due to scoring, it may be possible to free it up by removing score marks with crocus cloth.
7. Inspect the selector shaft and selector fork for signs of wear. Replace as required.
8. Inspect the idler gear and cluster gear as in step 4. Replace as required.
9. Examine the idler shaft and the cluster shaft for signs of wear. Replace as required.
10. Replace all thrust washers, "O" rings, gaskets and the main oil seal.

D. Assembly

1. Place the gear case (48), Figure 39, on the bed of an arbor press with rear end of the case facing up. Position the bearing cup (32) in the case with the wide shoulder of the cup facing down. Place Step Plate 630-13 on narrow shoulder of cup, bring the ram of press down on plate and press the cup into the case until it bottoms in the case.
2. Position the spacer (54) and roller bearings (52 and 55) in the bore of the cluster gear (53). Start the cluster gear shaft (50) in its bore in the rear end of the gear case. Position the cluster gear in the case. Place the thrust washer with the larger inside diameter next to the larger gear and the other thrust washer next to the smaller gear. Align washers with the gear assembly and tap the shaft into place.
3. Position the spacer (44) and roller bearings (42 and 45) in the bore of the idler gear (43). Start the idler shaft (40) in its bore in front end of the gear case. Position the idler gear in the case and in mesh with the cluster gear. Place the thrust washer with the larger inside diameter next to the face of the gear and the other washer next to the hub on the gear. Align the washers with the gear assembly and tap the shaft into place. Install the expansion plug (33) in its bore in the rear end of the case.
4. Place a new oil slinger (30) on the drive gear (29). Install the tapered bearing (31) on the drive gear, as shown in Figure 42. Be sure to press on the inner race of the bearing to avoid possible damage to the bearing assembly.
5. Position the drive gear assembly in the gear case with the tapered bearing seated in the bearing cup. Place the drive gear spacer (13), Figure

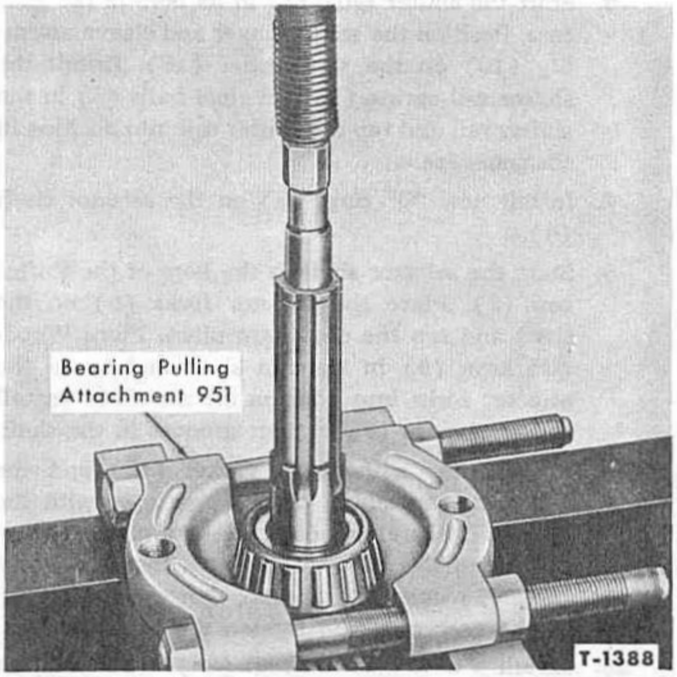


Figure 41—Removing Tapered Bearing from Drive Gear

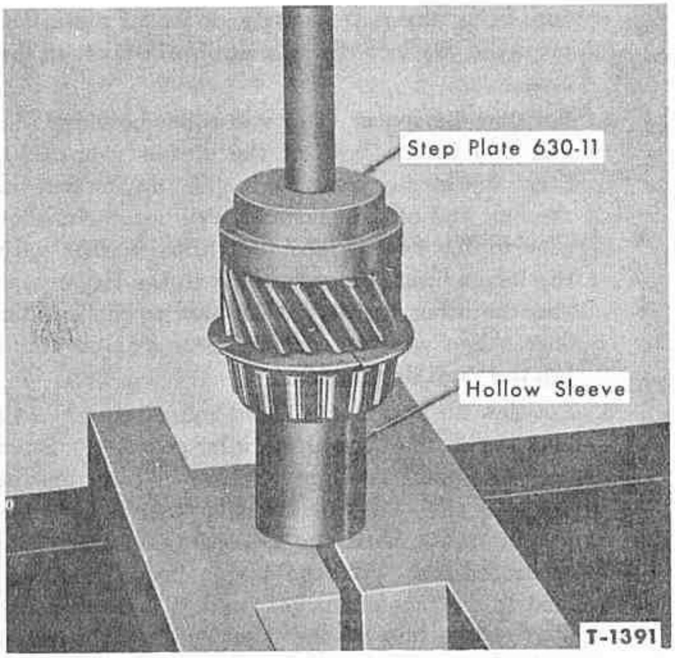


Figure 42—Installing Tapered Bearing on Drive Gear

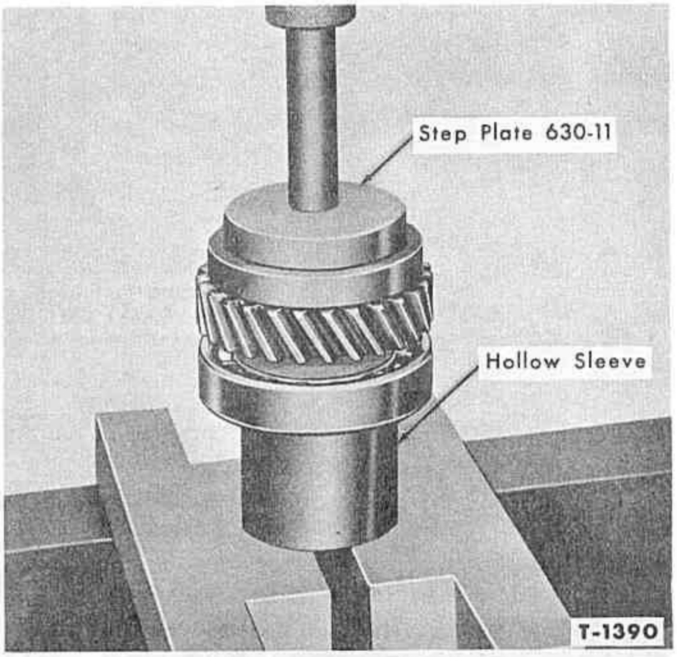


Figure 43—Installing Clutch Shaft Bearing

39, on the drive gear with the flat surface toward the bearing. Install in order, the two reverse gear roller bearings (14 and 16), the reverse gear (15) with the hub facing the spacer, the large thrust washer (17), the spline sleeve (19) and the shift collar (18). Be sure the groove for the shift collar is facing toward the front of the gear case. Install the snap ring (20) that retains the spline sleeve to the drive gear.

6. Start the shifter rail (11) in its bore in the gear case. Position the shifter finger and sleeve assembly (10) on the shift collar (18). Install the shifter rail spring (9) and steel balls (8) in the shifter rail and tap the shifter rail into position in the gear case.
7. Install new "O" rings (3) on the selector shaft (4).
8. Start the selector shaft in the bore of the shifter cap (2). Place the selector forks (6) on the shaft and tap the shaft into place. Place Woodruff keys (5) in slots in shaft and move the selector forks into position on the shaft. Install the snap rings (7) in their grooves in the shaft.
9. Position the shifter cap gasket (12) and the shifter cap assembly on the gear case with the selector forks engaged in the ears of the shifter finger and sleeve assembly (10). Install the four bolts (1) and lock washers that secure the cap to the gear case and tighten the bolts securely.
10. Install a new main oil seal (36) in the support housing (38).
11. Install the clutch shaft ball bearing (34) on the clutch shaft (24) using a press and a sleeve, as shown in Figure 43. Install the snap ring (35), Figure 39, in the groove in the shaft.
12. Install the clutch shaft and bearing assembly in the support housing. Install the large snap ring (23) in its groove in the support.
13. Install the magnetic drain plug (47) in the gear case.

E. Installation

1. Check the tractor transmission case face for burrs which might prevent proper seating or alignment of the mounting flange.
2. Install the mounting flange (26) in the tractor transmission with approximately 0.050″ thickness of shims between the flange and the main transmission case, as shown in Figure 44. The flat edge of the mounting flange must be at the top. Install the four Allen head cap screws (27), Figure 39, to secure the flange to the case. Position a new mounting flange gasket (28) on the gear case and install the transmission.
3. Add or remove shims as required to obtain the following adjustment:

   From the point where end play has just been removed; the transmission should be preloaded by removing 0.005″ to 0.007″ thickness of shims. The shaft will then offer snug resistance to hand rotation with no bind when using Shim Test Collar 10A747A as shown in Figure 45.

4. Add two pints of SAE 80 transmission oil to the Sherman Transmission. Place the clutch shaft roller bearing (22) in the bore in the gear end of the clutch shaft. Place the thrust washer (21) next to the roller bearing. Position a new support gasket (37) on the support housing and install the housing and clutch shaft as an assembly on the front end of the transmission. Secure the housing to the gear case with five bolts (39) and lock washers.
5. Install the clutch release bearing and hub assembly and the clutch release bearing springs.
6. Connect the tractor transmission to the tractor.

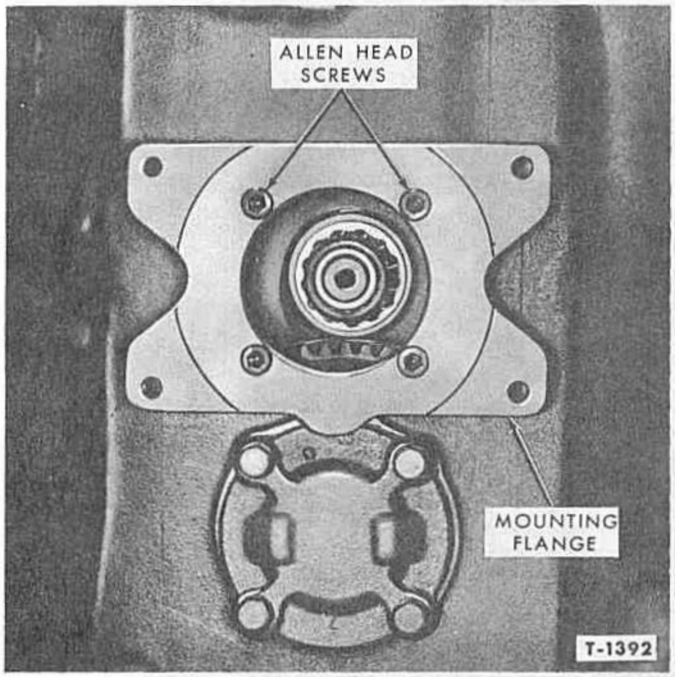


Figure 44—Mounting Flange Installed in Tractor Transmission Case

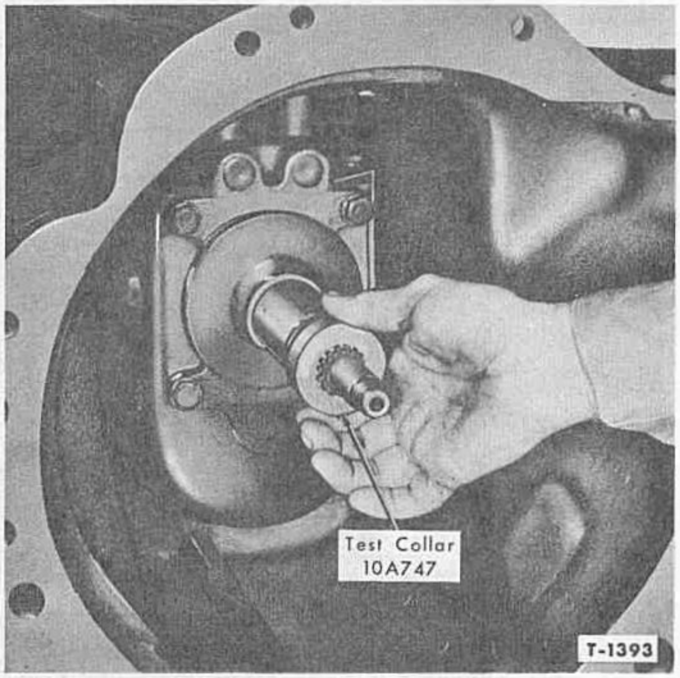


Figure 45—Checking Shimming with Test Collar

7. DESCRIPTION AND OPERATION—SELECT-O-SPEED TRANSMISSION

The Select-O-Speed Transmission is available in three models. The basic transmission remains unchanged for all tractors, and model designations refer only to the following power take-off options:

1. Model 11—No P.T.O.
2. Model 71—Single speed independent engine driven P.T.O.
3. Model 81—Two speed independent engine driven P.T.O., and proportional ground speed P.T.O.

The Ford Select-O-Speed Transmission provides for ease of control and high efficiency in the utilization of engine power and engine fuel. It is a manually selected, hydraulically controlled system, which transmits power from the engine through four planetary gear sets, providing the ten forward speed ratios and two reverse speed ratios to the final drive of the tractor. Two stationary positions, a park, and a neutral, are also provided.

A brief description and the principles of operation of the major assemblies in the transmission, are discussed in this section. All design and operational differences between the transmission models are fully explained.

PLANETARY GEAR TRAIN

For purposes of identification, the four planetary gear systems used in the Ford Select-O-Speed Transmission have been labeled, from front to rear, "A", "B", "C", and "D", as shown in Figure 46. The ten forward and two reverse speeds are obtained by controlling the movement of the elements within the planetary gear systems.

Each of the planetary gear systems is comprised of three elements; a sun gear, a carrier with three pinions,

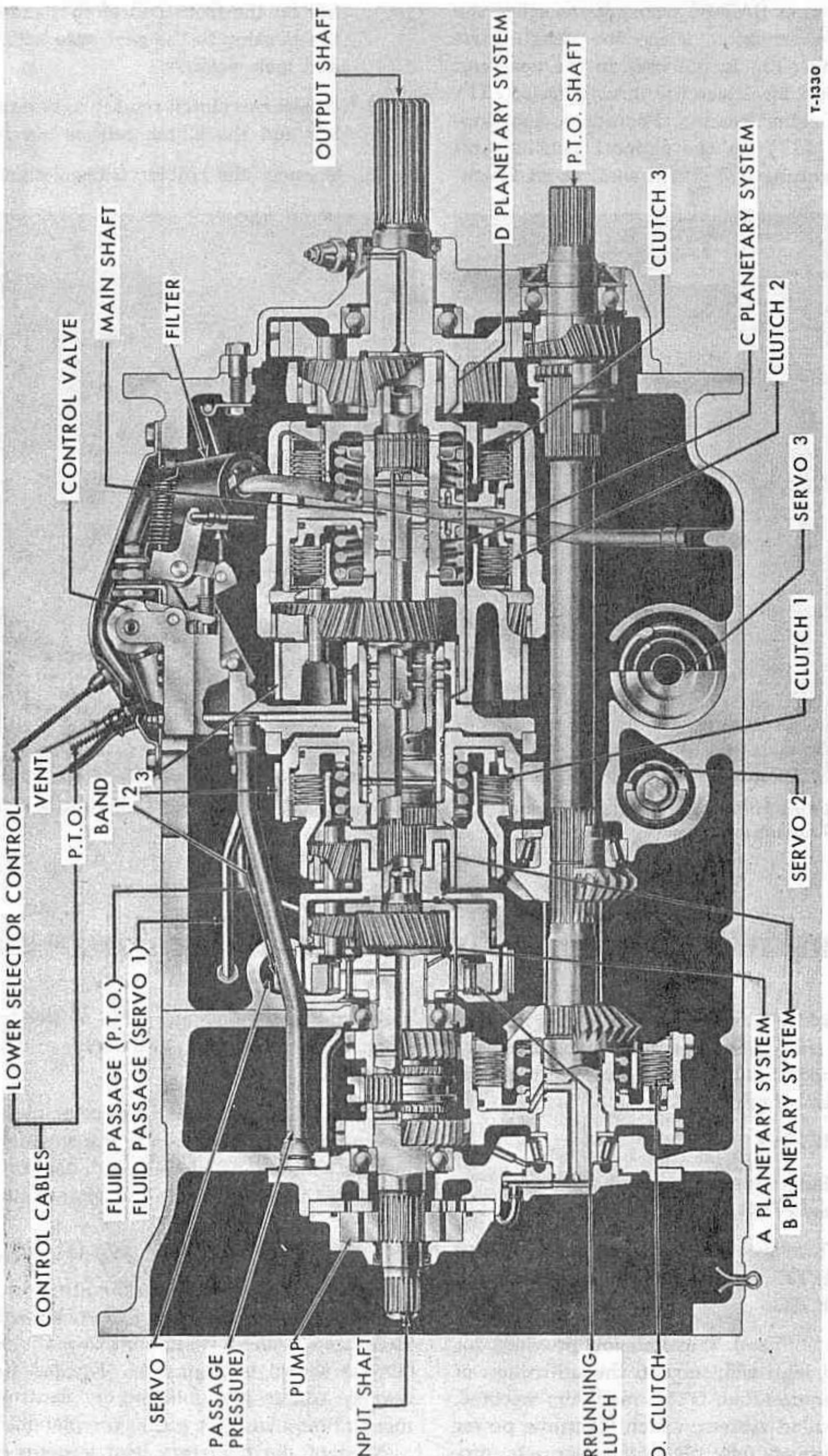


Figure 46—Select-O-Speed Transmission Model 81—Sectional View

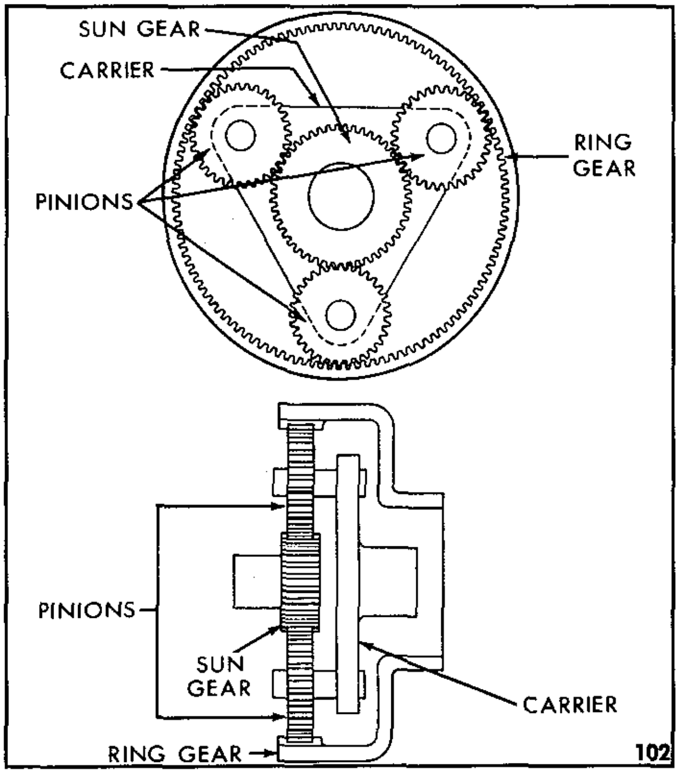


Figure 47—Planetary System—Front and Side View

and a ring gear, as shown in Figure 47. The three pinions are mounted within the carrier frame and rotate on needle bearings around pinion shafts, which are secured to the carrier frame. The sun gear, which is centered between the pinions has external teeth, and the ring gear, which encompasses the pinions has internal teeth. All of the gears in the planetary system are constantly in mesh.

When a planetary system is connected to a source of power, all of the components in the system will rotate unless an external force is applied to hold an element. The sun gear, carrier, and ring gear, can rotate on the central axis of the system and the pinions will rotate on their own axes at the same time as they are being carried around the central axis.

A. Planetary Gear Power Flow

Depending upon which element of a planetary system is held, power can be applied or taken out at the sun gear, carrier, or ring gear. The general flow of power through the planetary system will be as follows:

1. Applying power to the sun gear and holding the ring gear forces the pinions to rotate on their own axes and "walk" around the ring gear, taking the carrier with them. The carrier, therefore, becomes the power output member of the system, turning in the same direction but at a slower speed than the sun gear. This condition produces an underdrive ratio.
2. Applying power to the ring gear and holding the sun gear, forces the pinions to rotate on their own axes and "walk" around the sun gear taking the carrier with them. The carrier, therefore, becomes the power output member of the system, turning in the same direction but at a slower speed than the ring gear. This condition produces an underdrive ratio.
3. Applying power to the carrier and holding the ring gear forces the pinions to rotate on their own axes and "walk" around the ring gear. The sun gear, therefore, becomes the power output member of the system, turning in the same direction but at a higher speed than the carrier. This condition produces an overdrive ratio.
4. Applying power to the carrier and holding the sun gear, forces the pinions to rotate on their own axes and "walk" around the sun gear. The ring gear, therefore, becomes the power output member of the system, turning in the same direction but at a higher speed than the carrier. This condition produces an overdrive ratio.
5. Applying power to the sun gear and holding the carrier, forces the pinions to act as idlers, rotating in the opposite direction on their own axes. This drives the ring gear at a lower speed and in the opposite direction from the sun gear. This condition produces an underdrive reverse ratio.
6. Applying power to the ring gear and holding the carrier, forces the pinions to act as idlers, rotating in the same direction on their own axes. This drives the sun gear at a higher speed and in the opposite direction from the ring gear. This condition produces an overdrive reverse ratio.
7. Locking any two units of a planetary system together results in a direct drive with no change in speed or direction of rotation.

BANDS AND SERVOS

The Select-O-Speed Transmission is equipped with three servo-operated brake bands, shown in Figure 46, which are used to hold certain planetary gear elements in the transmission and are factors in the determination of the power flow through the transmission. These bands are made of steel and have metallic or asbestos composition linings bonded to the inside surface. For purposes of illustration and reference, the bands have been labeled 1, 2, and 3, as shown in Figure 46.

All three bands are controlled by corresponding hydraulic servos which contain a piston and rod, return spring, and spring retainer.

In operation, the servos control the action of the bands on the various planetary gear elements in the following manner:

A. Band No. 1

Band 1 encircles the drum attached to the planetary "A" sun gear. One end of the band contacts the inner end of the adjusting screw and the opposite end engages a strut between the band and the servo piston rod. When fluid pressure is directed to the servo, force is transmitted through the piston rod and strut to tighten the band around the drum. When hydraulic pressure is removed from the piston, the servo spring releases the band and exhausts the fluid.

B. Band No. 2

Band 2 encircles the clutch housing splined to the planetary "B" ring gear. One end of the band contacts a strut on the inner end of the adjusting screw. The other end of the band engages a strut between the band and servo 2 actuating lever. In operation, band 2 is mechanically applied by spring pressure until fluid pressure is directed to servo 2 to hydraulically release the band from the clutch housing. When the fluid pressure is removed, the spring discharges the fluid and applies the band.

C. Band No. 3

Band 3 encircles the planetary "C" carrier. One end of the band contacts a strut on the inner end of the adjusting screw and the opposite end engages the strut between the band and servo 3 actuating lever. In operation, band 3 is mechanically applied under spring pressure until fluid pressure is directed to servo 3 to hydraulically release the band from the carrier. When fluid pressure is removed, the spring discharges the fluid and applies the band.

The following chart shows band application and the other planetary elements affected:

Band	*Applied*	*Planetary Element Involved*
1	Hydraulically	Sun Gear "A"
2	*Mechanically	Ring Gear "B" and Sun Gear "C"
3	*Mechanically	Carrier "C"

*Bands 2 and 3 are hydraulically released.

CLUTCHES

A. Overrunning Clutch

The "A" planetary system of the Select-O-Speed Transmission incorporates an overrunning clutch, shown in Figure 46, located between the sun gear and the carrier. In operation, the overrunning clutch locks these two elements together whenever the sun gear attempts to rotate at a faster speed than the carrier. It releases whenever the sun gear is stopped, or is turned in the opposite direction from the carrier. Engagement of the overrunning clutch is controlled by the action of band 1 in the following manner:

Band 1 Released: With the "A" carrier splined to the transmission input shaft and rotating clockwise at engine speed, the initial resistance on the ring gear directs the power to the sun gear which will attempt to rotate faster than the carrier. This causes the overrunning clutch rollers or sprags to lock the carrier to the sun gear, which prevents the pinions from rotating on their own axes, and the complete "A" planetary system is locked together. Therefore, the ring gear, which will also rotate clockwise at engine speed, transfers the power to the "B" planetary system in a direct drive condition.

Band 1 Applied: With the "A" carrier splined to the transmission input shaft and rotating clockwise at engine speed, the sun gear is held stationary by band 1. The overrunning clutch allows the carrier to freely overrun the sun gear. Now, the pinions "walk" around the sun gear as they are being carried around the central axis, and the ring gear, which is being driven faster than the carrier, transfers power to the "B" planetary system in an overdrive condition.

When band 1 is released, the overrunning clutch will automatically engage.

B. Clutch Packs

In addition to the holding devices used to control planetary gear operation, the Select-O-Speed Transmission incorporates three multiple-disc clutch packs. For purposes of illustration and reference, the clutch packs have been labeled 1, 2, and 3, as shown in Figure 46. These clutches are used to link two elements of one planetary system or the elements of adjacent planetaries together to obtain the desired power flow. The three hydraulically operated clutch packs in the transmission are all basically the same and are composed of the clutch housing, the clutch piston, the piston inner seal, the piston outer seal, a return spring and retainer, five steel plates, five bronze plates, a pressure plate and retainer snap ring. The steel plates have external splines which engage with the clutch housing and the bronze plates have internal splines which engage a planetary gear element.

When fluid pressure is applied to a clutch pack, the movement of the piston compresses the return spring and plates, and engages the clutch. The piston is returned to the released position by the return spring after hydraulic pressure has been removed. The steel clutch plates contain a slightly dished form to maintain positive separation while the clutch is released.

The function of each individual clutch assembly is listed in the following table.

Clutch	*Planetary Elements Combined*
1	Carrier "B"-Ring Gear "B"
2	Carrier "B"-Carrier "C"
3	Carrier "B"-Sun Gear "D"

TRANSMISSION POWER FLOWS

When certain combinations of elements in the planetary gear train of the Select-O-Speed Transmission are held by the bands and others linked together by the clutches, the flow of power through the transmission provides ten forward speed ratios and two reverse speed ratios. All of the basic power flows are illustrated and described in this section.

A. Direct Drive and Overdrive

The power flow through the "A" planetary system, shown in Figure 48, is always the same. The carrier is splined to the transmission input shaft and power is taken out at the ring gear. The only function of the "A" planetary system is to transmit power from the engine to the "B" planetary system either at engine speed, for a direct drive condition, or at an increased speed, providing an overdrive condition. When band 1 is released, the overrunning clutch locks the sun gear to the carrier and the "A" planetary system rotates as a unit at engine speed. When band 1 is applied to hold the sun gear, the overrunning clutch automatically releases and the rate of rotation increases as power is taken out at the ring gear.

B. Primary Variable Reduction

The six basic speed ratios, five forward and one reverse, are obtained through the various combinations of holding or driving elements in the "B" and "C" planetary systems only. Therefore, ten forward speeds and two reverse speeds are made possible by the dual range characteristics of the "A" planetary system.

C. Final Reduction

The "D" planetary system, shown in Figure 48, is

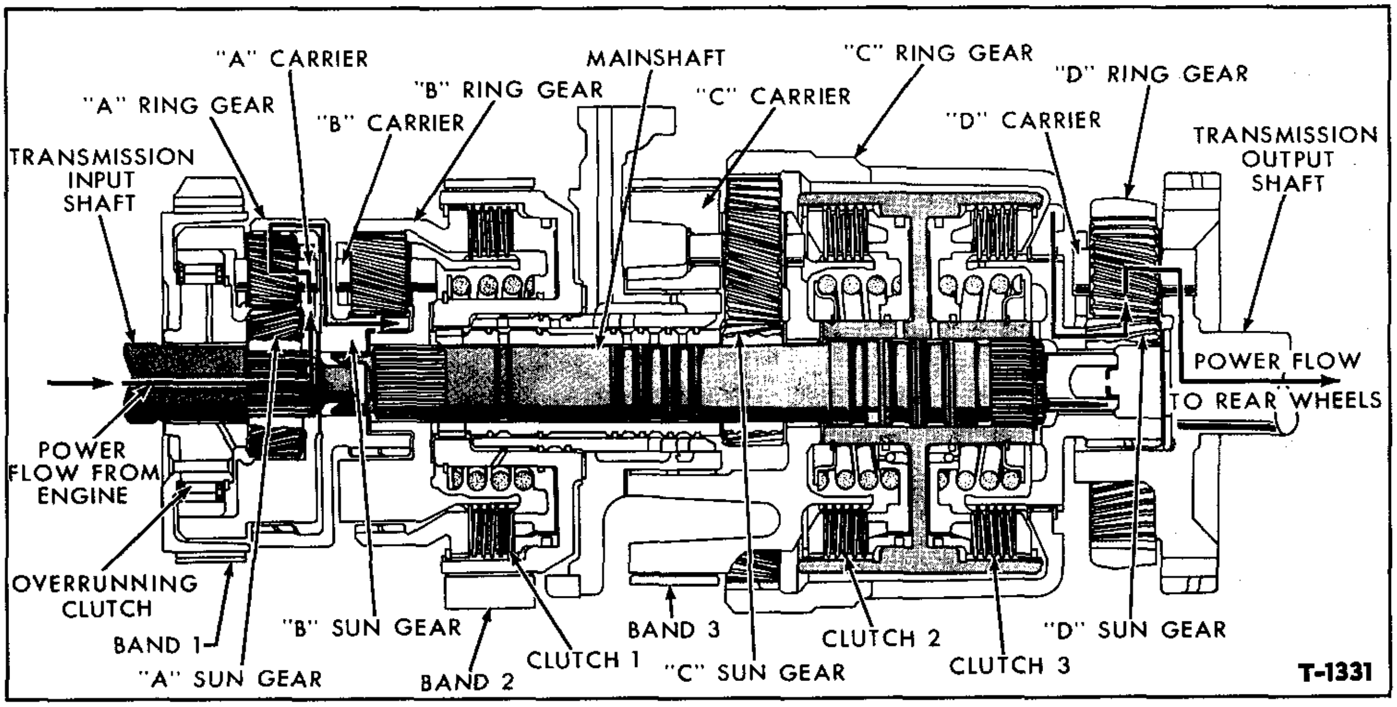


Figure 48—Select-O-Speed Planetary Gear Train

always used to reduce the high speeds developed within the transmission to the required operating speeds and deliver the flow of power through the output shaft. The power will always enter the "D" planetary at the sun gear and go out through the carrier which is integral with the output shaft.

D. Power Flow—Park Position

To provide the park position, which prevents any movement of the tractor, band 2 is applied to hold the "B" ring gear and "C" sun gear, and band 3 is also applied to hold the "C" carrier, as shown in Figure 49. With the "B" sun gear turning clockwise, the pinions "walk" around the "B" ring gear causing the "B" carrier, mainshaft, and housing for clutches 2 and 3, to rotate. Since neither clutch 2 nor clutch 3 is engaged, power is not transmitted to the "D" sun gear. Since "C" carrier is being held stationary by band 3 and the "C" sun gear is being held by band 2, the "C" planetary system is locked and will prevent the rear wheels from turning.

E. Power Flow—Reverse Speed Ratios

The basic reverse speed ratio is obtained by applying band 3 to hold the "C" carrier, and linking the "B" carrier to "B" ring gear with clutch 1, as shown in Figure 50. Rotation of the "B" sun gear causes the "B" planetary system to turn clockwise as an assembly. The "C" sun gear is, therefore, driven clockwise resulting in the counterclockwise rotation of the "C" ring gear and "D" sun gear.

Reverse 2, being the overdrive ratio of reverse 1, is obtained by the application of band 1.

F. Power Flow—Neutral

When the transmission is in neutral, only band 3 is applied to hold the "C" carrier, as shown in Figure 51. The clockwise rotation of the "B" sun gear causes the pinions to "walk" around the "B" ring gear resulting in the rotation of the "B" carrier, mainshaft, and the housing for clutches 2 and 3. Since neither clutch is engaged, power is not transmitted to the "D" sun gear. The rear wheels are now free to turn as the "B" ring gear can rotate around the pinions.

G. Power Flow—First and Third Speed Ratios

The basic ratio is obtained by holding the "C" carrier with band 3 and linking the "B" carrier to the "D" sun gear with clutch 3, as shown in Figure 52. This combination mechanically links both the "B" carrier and the "B" ring gear to the output shaft and results in a divided power flow. With the "B" sun gear turning clockwise, the "B" pinions will revolve counterclockwise and initiate the divided power flow to the "C" ring gear. On one side of the divided power flow, the "B" pinions spend a part of their rotation to "walk" clockwise around the inside of the "B" ring gear and thereby drive the "B" carrier, mainshaft, clutch 3, and "D" sun gear in a clockwise direction. On the other side of the divided power flow, the "B" pinions spend a part of their rotation to drive the "B"

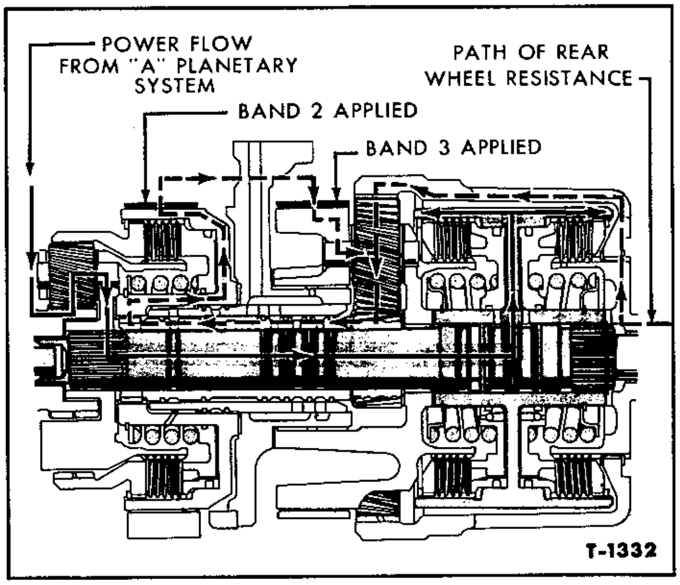

POWER FLOW FROM "A" PLANETARY SYSTEM
PATH OF REAR WHEEL RESISTANCE
BAND 2 APPLIED
BAND 3 APPLIED
T-1332

Figure 49—Power Flow—Park Position

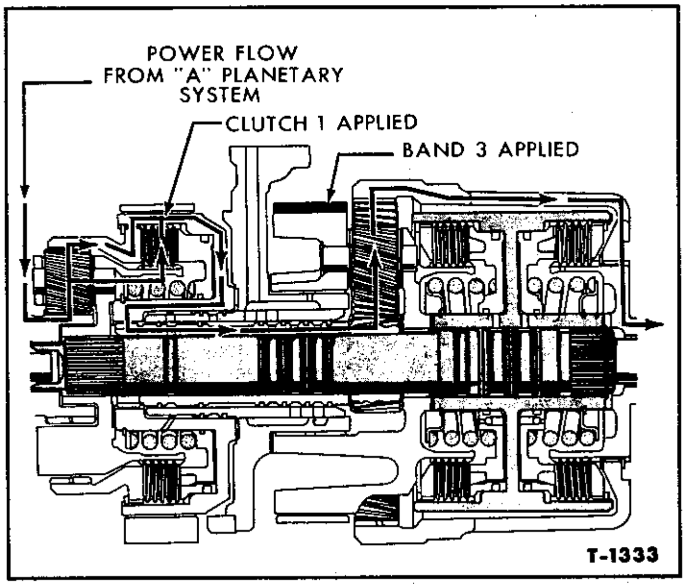


Figure 50—Power Flow—R1 and R2 Speed Ratio

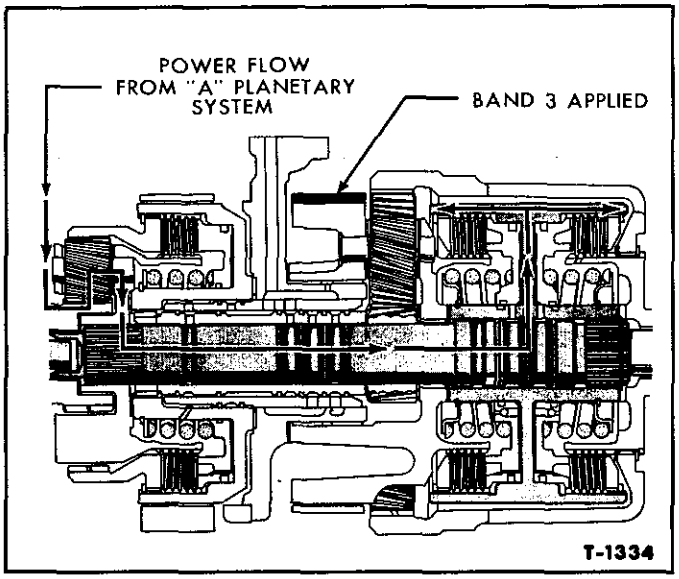


Figure 51—Power Flow—Neutral

ring gear and the "C" sun gear in a counterclockwise direction. The "C" sun gear drives the "C" pinions which cannot orbit the central axis because band 3 is holding their carrier. Therefore, the "C" pinions rotate clockwise on their own axes and drive the "C" ring gear and the "D" sun gear in the same direction. Thus, two distinct drives are established between the "B" pinions and the "C" ring gear. This type of drive permits a high reduction ratio. Third speed, being the overdrive ratio of first, is obtained by the application of band 1.

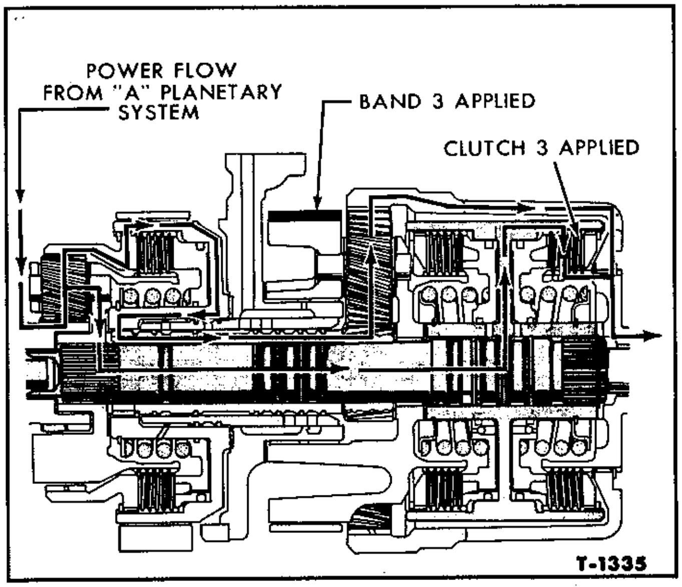


Figure 52—Power Flow—First and Third Speed Ratios

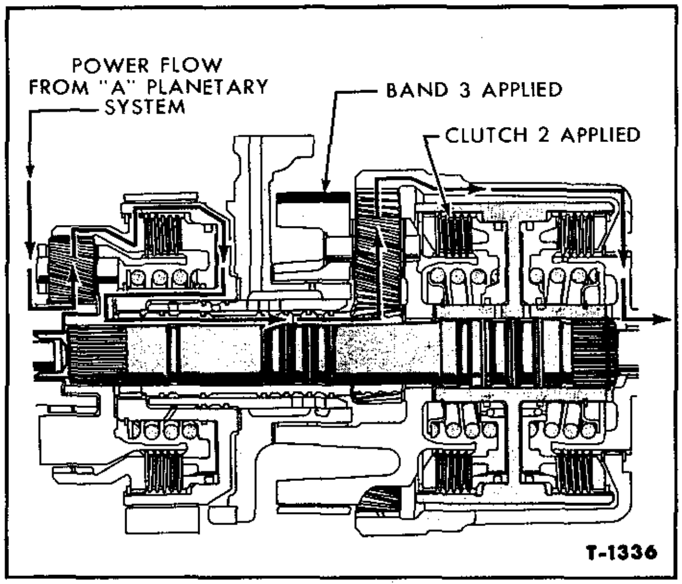


Figure 53—Power Flow—Second and Fourth Speed Ratios

H. Power Flow—Second and Fourth Speed Ratios

The basic speed ratio is obtained by holding the "C" carrier with band 3 and linking the "B" carrier to "C" carrier with clutch 2, as shown in Figure 53. With both the "C" carrier and the "B" carrier being held, neither the "C" pinions nor the "B" pinions can orbit the central axis. Clockwise rotation of the "B" sun gear causes the "B" pinions to rotate on fixed axes driving the "B" ring gear and "C" sun gear in a counterclockwise direction. The "C" sun gear causes the "C" pinions to rotate on fixed axes driving the "C" ring gear and "D" sun gear in a clockwise direction.

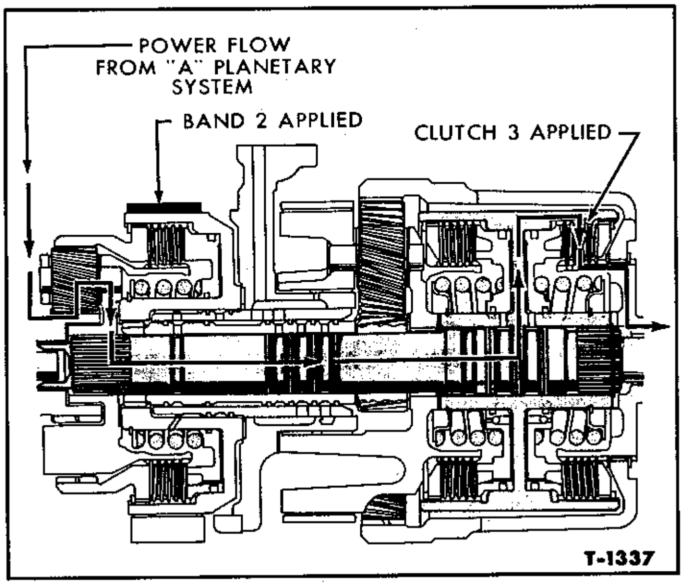


Figure 54—Power Flow—Fifth and Seventh Speed Ratios

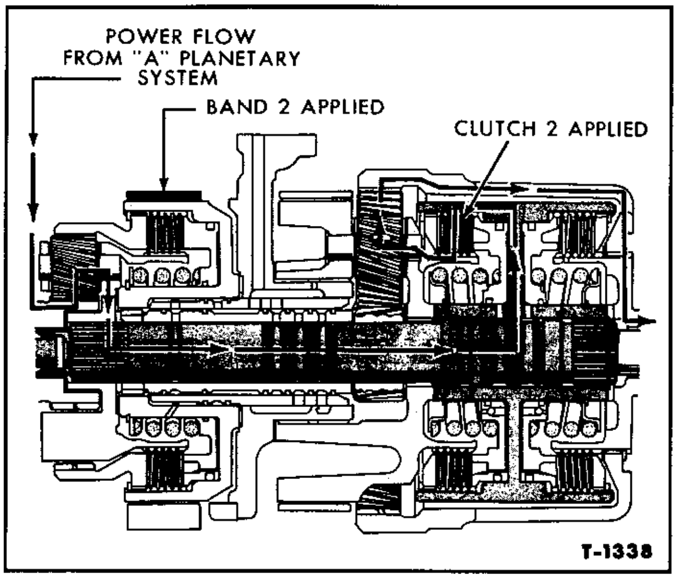


Figure 55—Power Flow—Sixth and Eighth Speed Ratios

Fourth speed, being the overdrive ratio of second, is obtained by the application of band 1.

I. Power Flow—Fifth and Seventh Speed Ratios

The basic speed ratio is obtained by holding the "B" ring gear with band 2 and linking the "B" carrier to "D" sun gear with clutch 3, as shown in Figure 54. With band 2 holding the "B" ring gear, the clockwise rotation of the "B" sun gear causes the pinions to "walk" around the ring gear and drive the "B" carrier, mainshaft, and "D" sun gear in a clockwise direction.

Seventh speed, being the overdrive of fifth, is obtained by the application of band 1.

J. Power Flow—Sixth and Eighth Speed Ratios

The basic speed ratio is obtained by holding the "B" ring gear and "C" sun gear with band 2, and linking the "B" carrier to "C" carrier with clutch 2, as shown in Figure 55. With band 2 holding the "B" ring gear, the clockwise rotation of the "B" sun gear causes the pinions to "walk" around the ring gear driving the "B" carrier, mainshaft, and "C" carrier in a clockwise direction. Since the "C" sun gear is also being held, the pinions "walk" around the sun gear driving the "C" ring gear and "D" sun gear in a clockwise direction.

Eighth speed, being the overdrive of sixth, is obtained by application of band 1.

K. Power Flow—Ninth and Tenth Speed Ratios

The basic speed ratio is obtained by linking the "B" carrier to "B" ring gear with clutch 1, and linking the "B" carrier to "C" carrier with clutch 2, as shown in Figure 56. As the "B" sun gear rotates clockwise, the complete "B" planetary system turns as an assembly driving the mainshaft, "C" sun gear and "C" carrier at the same speed. This results in the "C" planetary system rotating as an assembly with the ring gear driving the "D" sun gear clockwise at the same speed.

Tenth speed, being the overdrive of ninth, is obtained by the application of band 1.

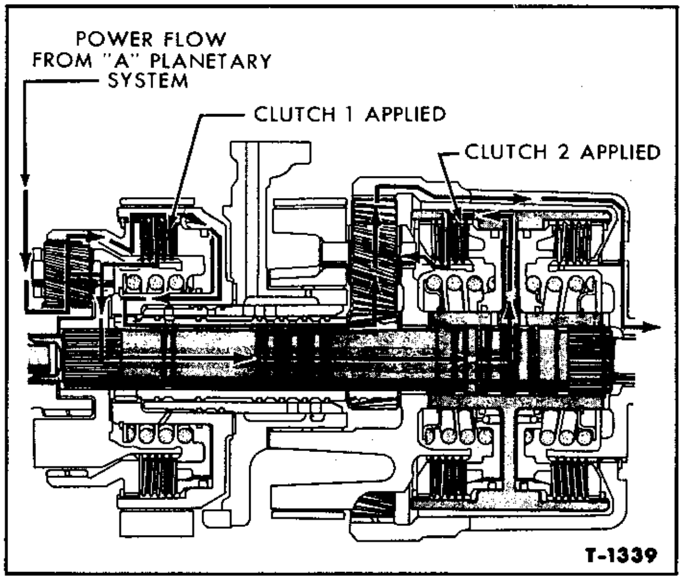


Figure 56—Power Flow—Ninth and Tenth Speed Ratios

HYDRAULIC CONTROL SYSTEM

A. Reservoir

The hydraulic fluid reservoir for this system is the transmission case which has a capacity of 11.5 quarts. The fluid pumped from the reservoir passes through a 40-mesh strainer screen which can easily be removed for cleaning or draining the system.

B. Pump

The pump, shown in Figure 46, is a roller vane type which supplies fluid pressure to the control valve through the pressure port in the distributor. The pump, driven by the transmission input shaft, operates whenever the engine is running and will supply a sufficient quantity of fluid to maintain the required operating pressure and lubricate the entire transmission system.

C. Distributor

The distributor is mounted co-axially on the transmission mainshaft and is secured to the center web of the transmission case, as shown in Figure 46. The distributor serves the function of channeling all of the fluid to and from the control valve assembly. Tubing connects the pressure side of the pump to the distributor, and the control valve mounts directly on top of the distributor, as shown. All of the fluid pressure flows from the control valve directly into corresponding ports in the distributor which, in turn, delivers the fluid to clutch pack 1, the mainshaft for operation of clutch packs 2 and 3, for pressure lubrication, and to the interlock cover assembly for operation of servos 2 and 3. Two separate lines extend from the distributor to direct fluid pressure to servo 1 and the P.T.O. clutch pack. Seals similar to piston rings are used on the main shaft to control the fluid between rotating components in the system.

D. Control Valve Assembly

The control valve assembly is mounted directly on top of the distributor, as shown in Figure 46, and consists of upper and lower body assemblies. It separates the hydraulic system in the Select-O-Speed Transmission into the following circuits:

The direct transmission circuit from the pump to the two speed valves which actuate servos 2 and 3.

The indirect transmission circuit containing the transmission feathering and regulating valves, and the spool valves which actuate clutches 1, 2, and 3, and band 1.

The indirect P.T.O. circuit which contains the P.T.O. feathering and regulating valves used to control fluid pressure on the P.T.O. clutch.

The indirect lubrication circuit which receives its fluid from the system relief valve and contains a plunger type relief valve set to maintain 43 psi at the opening to the lubrication circuit. Complete lubrication of the transmission is accomplished by the bleeding of fluid at specific locations along the mainshaft.

The control valve is actuated by a flexible cable coming from the selector assembly which rotates the cable wheel and camshaft assembly attached to the valve upper body. Six cam followers operate the six spool valves in the lower body which control the three clutch pistons and three band servos. A safety switch mounted on the control valve permits the tractor engine to be started only when the selector lever is in the (P) park position. This switch is actuated by the camshaft assembly. As the selector is moved to (P) park the cam closes the switch completing the circuit to the tractor starter switch.

Four adjustable spring-loaded, plunger-type valves are incorporated in the valve upper body to control the system pressure, lube pressure, and regulate or sequence oil flow first to the direct circuit. In addition, in the valve lower body, feathering valves are incorporated to control the oil flow in the transmission and P.T.O. indirect circuits.

System Relief Valve: The necessary operating pressure required in this system is regulated by a system relief valve located in the valve upper body, shown in Figure 57, which is set to maintain 180 psi at an engine speed of 800 rpm.

Lubrication Pressure Valve: All of the excess hydraulic fluid passed over the relief valve is directed to a lubrication pressure valve located in the valve upper body, shown in Figure 57. Therefore, the lubrication pressure valve will not receive any fluid until system pressure exceeds the system relief valve pressure setting. This will be indicated to the operator by a transmission lube pressure light located on the instrument panel. The lubrication valve is set to maintain 43 psi in the lubrication circuit, which is enclosed within the mainshaft of the transmission, as shown in Figure 46. All of the fluid by-passing this valve is returned directly to the sump by the discharge oil tube assembly or filter tube, at a point below the oil level in the sump to decrease oil foaming.

Regulating Valves: Two additional regulating valves are located in the valve upper body. One is in the indirect transmission circuit containing the spool valves for servo 1, and clutches 1, 2, and 3. The other is in the P.T.O. clutch circuit. These valves are set at 150 psi, and operate as follows:

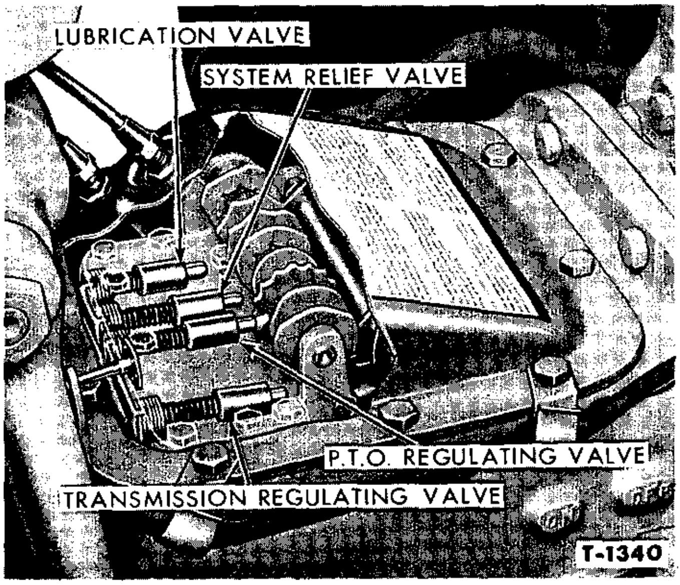


Figure 57—Control Valve Assembly

1. As pressure within the system is building up, both regulating valves will remain closed and allow all of the fluid to be first directed to servos 2 and/or 3. This will eliminate the possibility of creating a temporary locked condition in the transmission during the gear ratio changes since the combination of bands 2 and 3 both applied is used in Park. This arrangement also allows smoother shifting characteristics.
2. When the fluid pressure being directed to either the transmission circuit consisting of C_1, C_2, C_3, and B_1 spools, or the P.T.O. circuit is partially relieved by the action of either feathering valve, pressure in the system will tend to drop below the regulating valves setting of 150 psi. To maintain sufficient pressure in the direct circuit to servos 2 and 3 and the transmission or P.T.O. indirect circuit, whichever is not being relieved, both regulating valves function as check valves to permit the servos and/or clutches in the unaffected circuits to operate satisfactorily.

Transmission Feathering Valve: The transmission feathering valve is used to maneuver the tractor very slowly or slightly, as required, when hitching or unhitching implements, and as a means of interrupting the power flow to the rear wheels. This valve is controlled by a foot pedal on the left side of the transmission case.

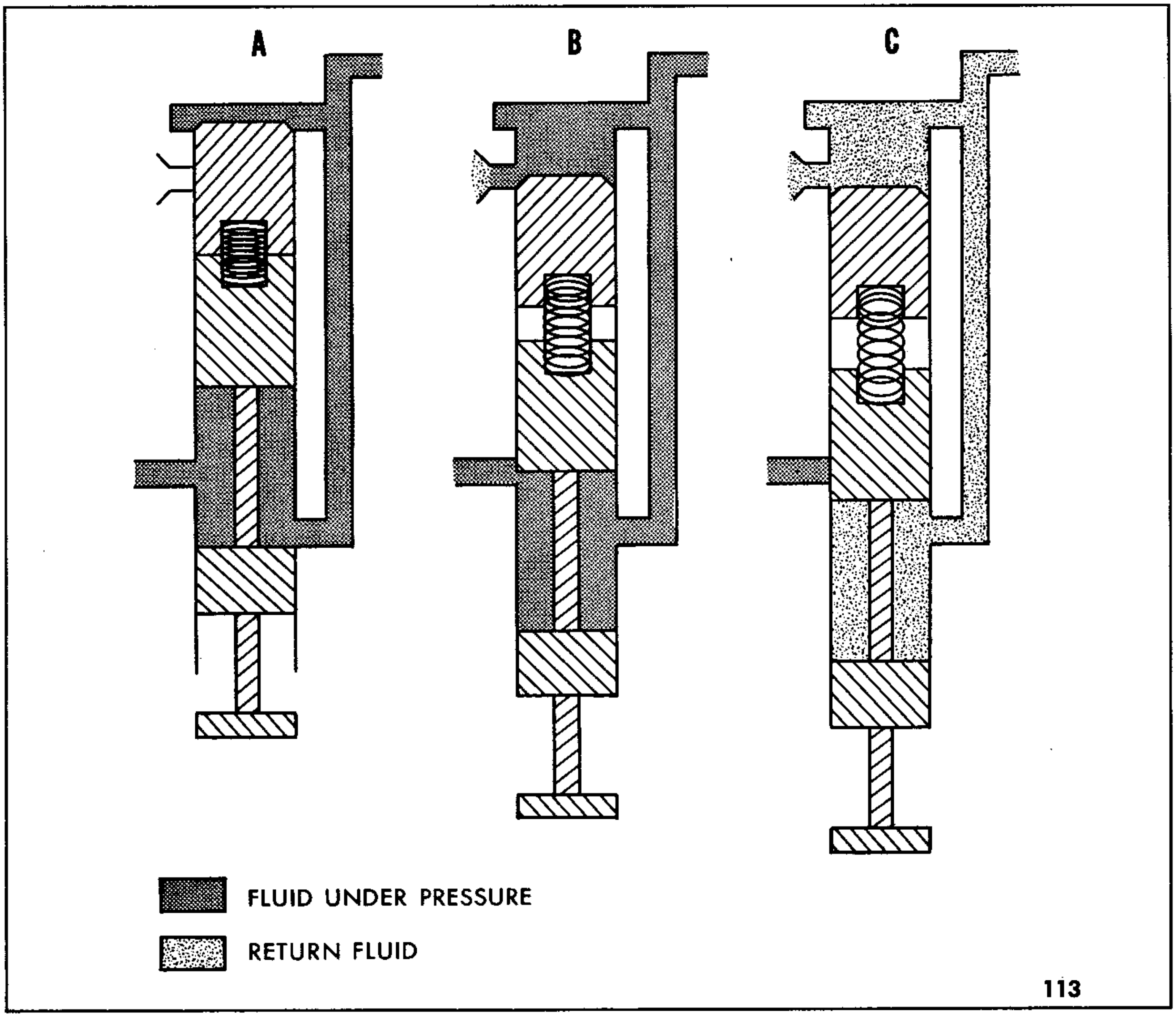


Figure 58—Feathering Valve Operation

The feathering valve is located in the indirect circuit ahead of the spool valves which control the transmission clutches and servo 1. During normal operation, the feathering valve is closed against fluid flow to the sump, as shown at (A), Figure 58. When the foot pedal is completely depressed, fluid pressure is released at all elements in the indirect circuit and no engine power will be transmitted to the rear wheels. This position of the feathering valve is shown at (C), Figure 58. When the foot pedal is raised slowly from the depressed position, fluid pressure will gradually increase and the elements in the indirect circuit will slowly engage. This is the "feathering" position of the valve, and is shown at (B), Figure 58.

P.T.O. Feathering Valve: On Model 71 and 81 transmissions, the action of the P.T.O. feathering valve is controlled by a "T" handle and rod assembly mounted in the right side of the tractor hood. The control handle and P.T.O. feathering valve, located in the control valve lower body, affect the fluid pressure in the P.T.O. circuit only. When the handle is pulled out slowly, the feathering valve will move further into the control valve body. As the valve moves into the body, it opens a pressure port allowing fluid into the passage to the P.T.O. clutch. This fluid will at first be free to pass to sump. This position of the valve is shown at (B), Figure 58. As the valve continues to travel inward, the passage to sump will gradually be closed and increasing fluid pressure will be exerted on the P.T.O. clutch piston, causing the clutch to be gradually engaged. This position of the valve is shown at (A), Figure 58. This will facilitate the gradual starting of P.T.O. operated equipment. When the feather-valve is in the extreme "OUT" position, with the control handle forward, the fluid pressure is entirely excluded from the P.T.O. circuit and the fluid in the P.T.O. clutch will be forced to return to sump by action of the P.T.O piston return spring. The clutch will then be disengaged. This position of the valve is shown at (C), Figure 58.

Spool Valves: The six spring-loaded, off-and-on spool-type valves which direct the fluid pressure to the three clutch packs and three servos are located in the control valve lower body and are interchangeable. The operation of these valves is controlled by the six cam followers. As certain combinations of valves are moved further into the control valve body, fluid pressure is directed to the specific clutch pistons, and/or band servos to obtain the various speed ratios. When the force is removed from the cam follower, the valve automatically returns to the "OUT" position by spring action.

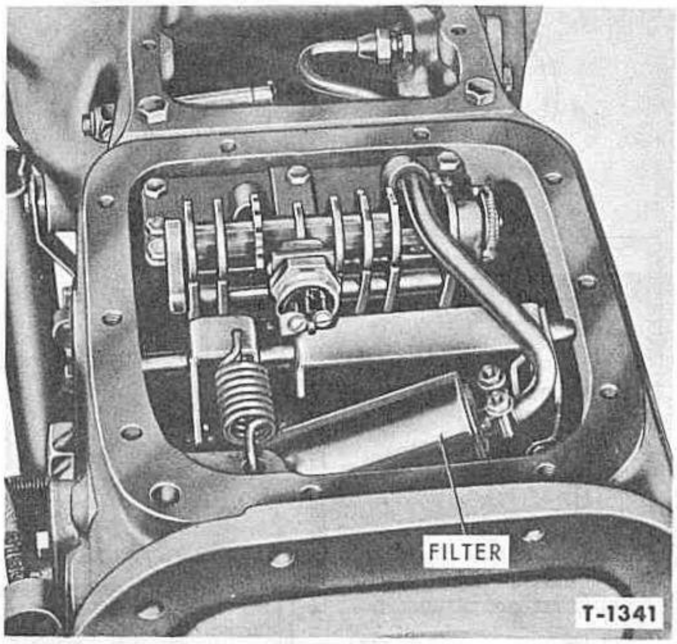


Figure 59—Select-O-Speed Filter

E. Filter Assembly

The Filter Assembly, shown in Figure 59, will remove foreign material that is carried in suspension in the transmission oil. The filter element is a replaceable pleated paper type with a pressure relief valve set at 7 to 9 psi to permit the filter to bypass if the element becomes clogged.

F. Interlock Assembly

The external cover assembly for servos 2 and 3, located on the left side of the transmission, incorporates a hydraulic interlock which functions to prevent bands 2 and 3 from being applied simultaneously when shifting between fourth and fifth speeds. The fluid flow from these servos must be controlled as the application of both bands 2 and 3 will cause a braking action.

Fluid pressure being directed to either servo 2 or servo 3 travels from the distributor into passages in the interlock cover. Valves located in these fluid passages to servos 2 and 3, as shown in Figures 60 through 67, are mechanically linked to the piston of the opposite servo.

When the shift from fourth to fifth speed is made, band 3, which has been mechanically applied, must be hydraulically released and band 2 must mechanically apply. As the fluid pressure directed to servo 3

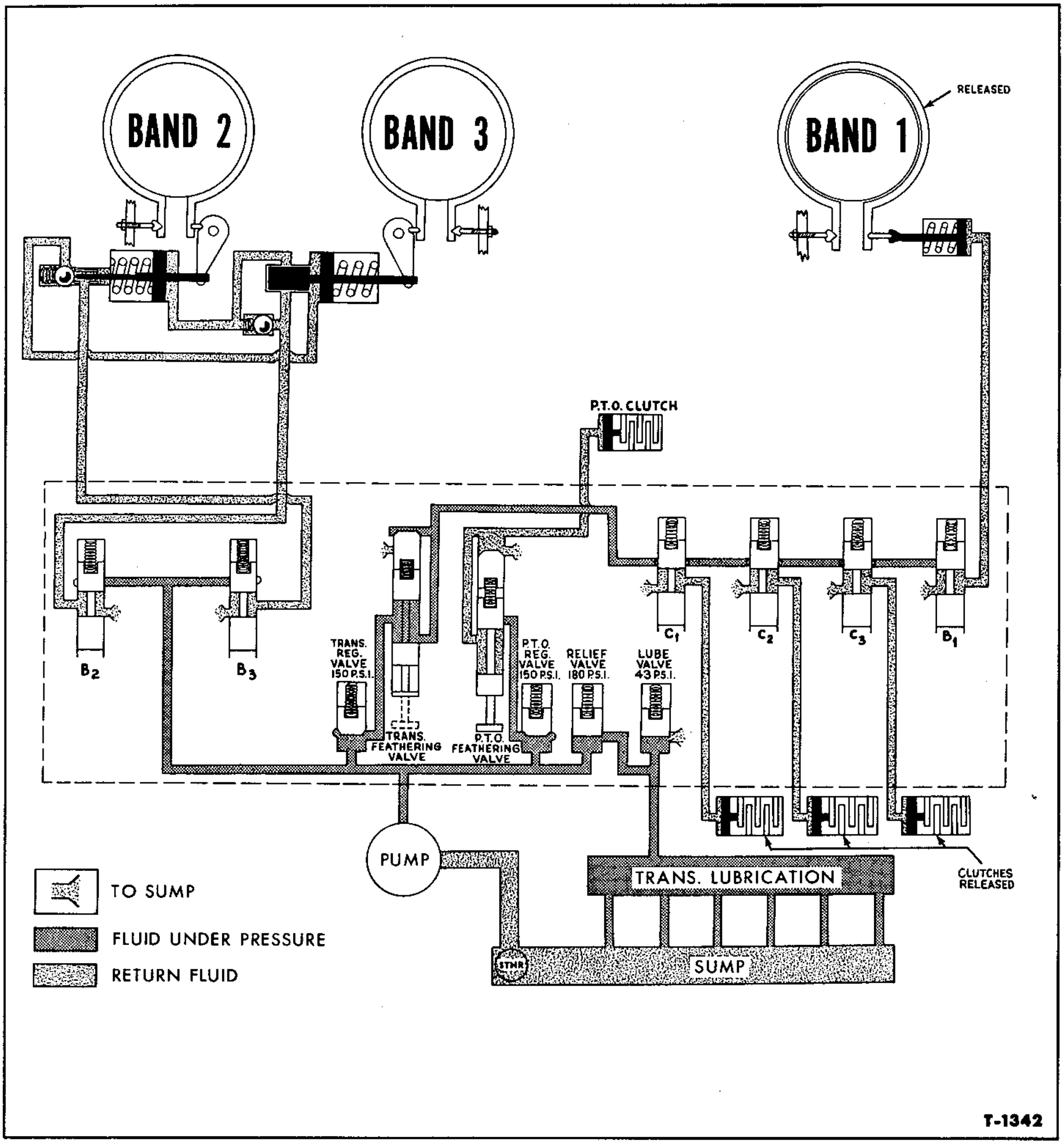


Figure 60—Hydraulic Control System—Park Position

acts on the piston and compresses the springs, the valve attached to the piston is withdrawn from its position blocking the fluid passage to servo 2 in the interlock cover permitting the fluid from servo 2 to return to sump and allowing the mechanical application of band 2. When shifting from fifth speed to fourth speed, the reverse action takes place and band 2 must be hydraulically released and band 3 must mechanically apply. As fluid pressure is directed to servo 2, the spring pressure is overcome and the piston and piston rod move outward toward the cover, releasing

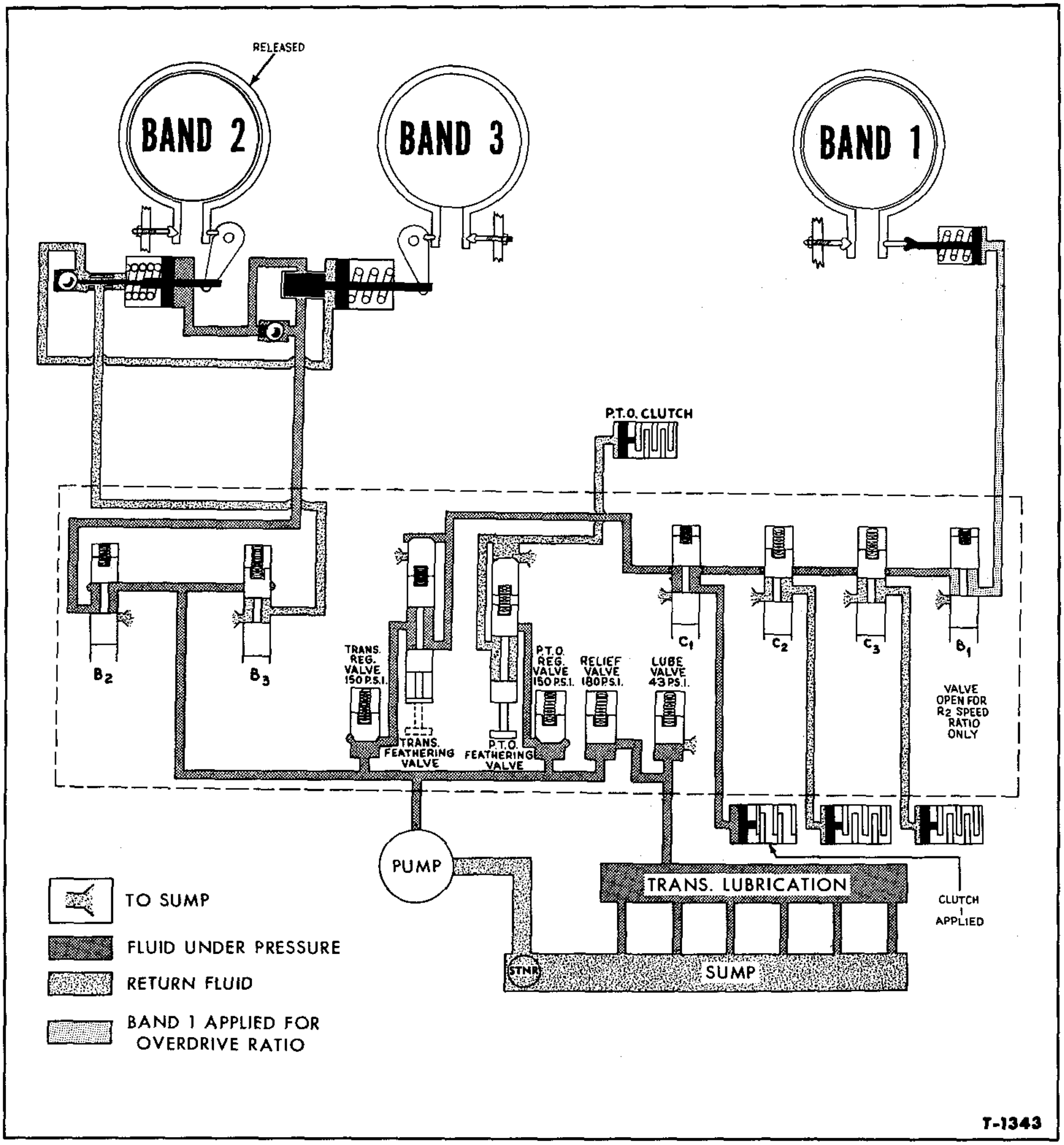


Figure 61—Hydraulic Control System—Reverse Speed Ratios

the band, and contacting the plunger which unseats the ball check valve located in the fluid passage to servo 3. Now the fluid in servo 3 is permitted to exhaust to sump and band 3 will be applied by spring pressure.

As shown in Figures 64 and 65, fluid pressure being directed to either servo will quickly unseat the ball check valve in its path. The interlock assembly only functions to restrict fluid return to sump, thereby preventing a possible lock-up condition when chang-

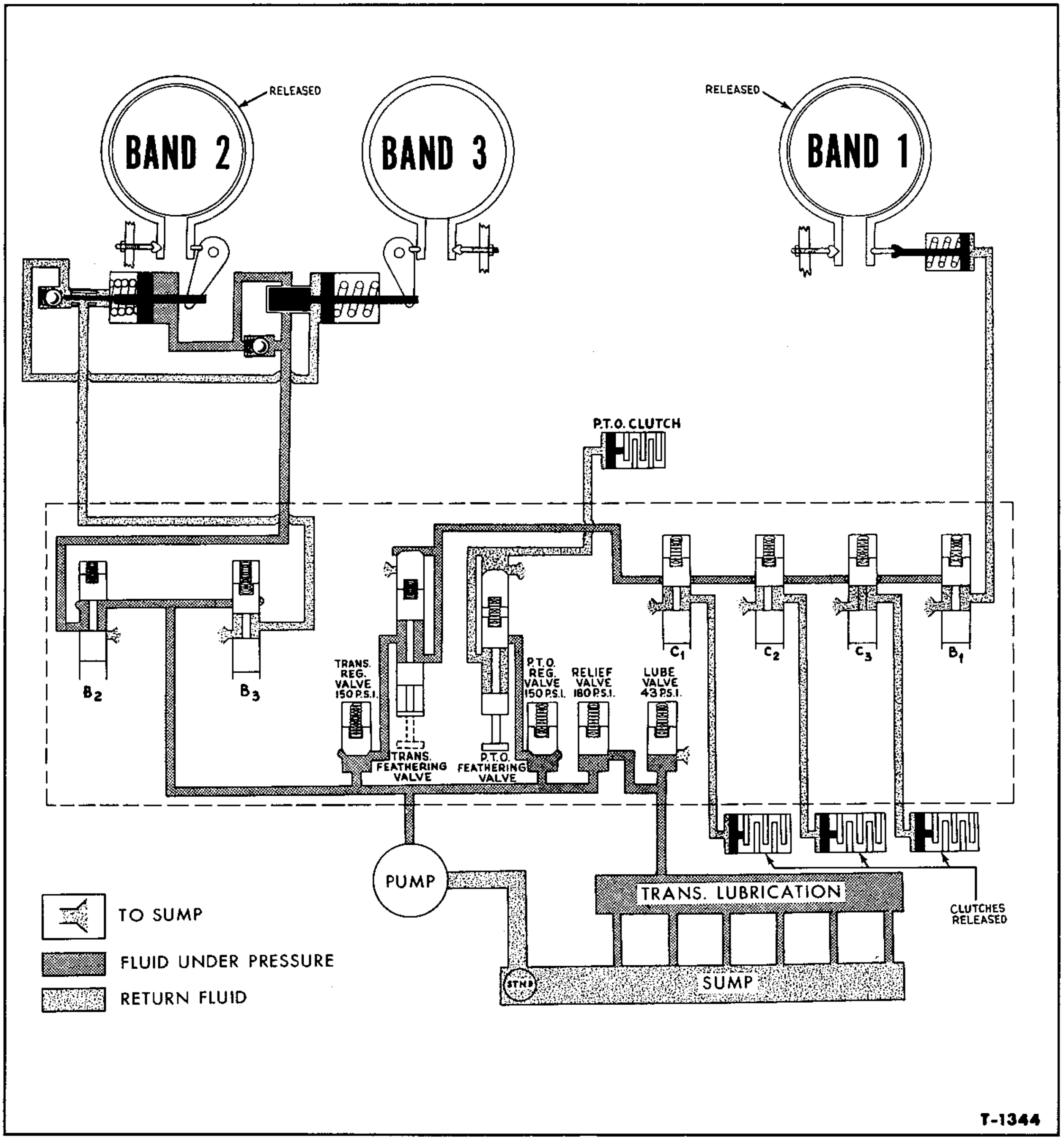


Figure 62—Hydraulic Control System—Neutral

ing forward speed ratios. However, the transmission will always go to (P) park whenever the system pressure is eliminated. Bands 2 and 3 apply gradually as metering notches at the check valves permit the fluid to bleed out under the return spring pressure of the servos.

G. Hydraulic Control System Operation

The proper operation of the Select-O-Speed Transmission is provided by the hydraulic control system which controls the flow of fluid pressure to the clutch packs and servos. The details of the fluid action to

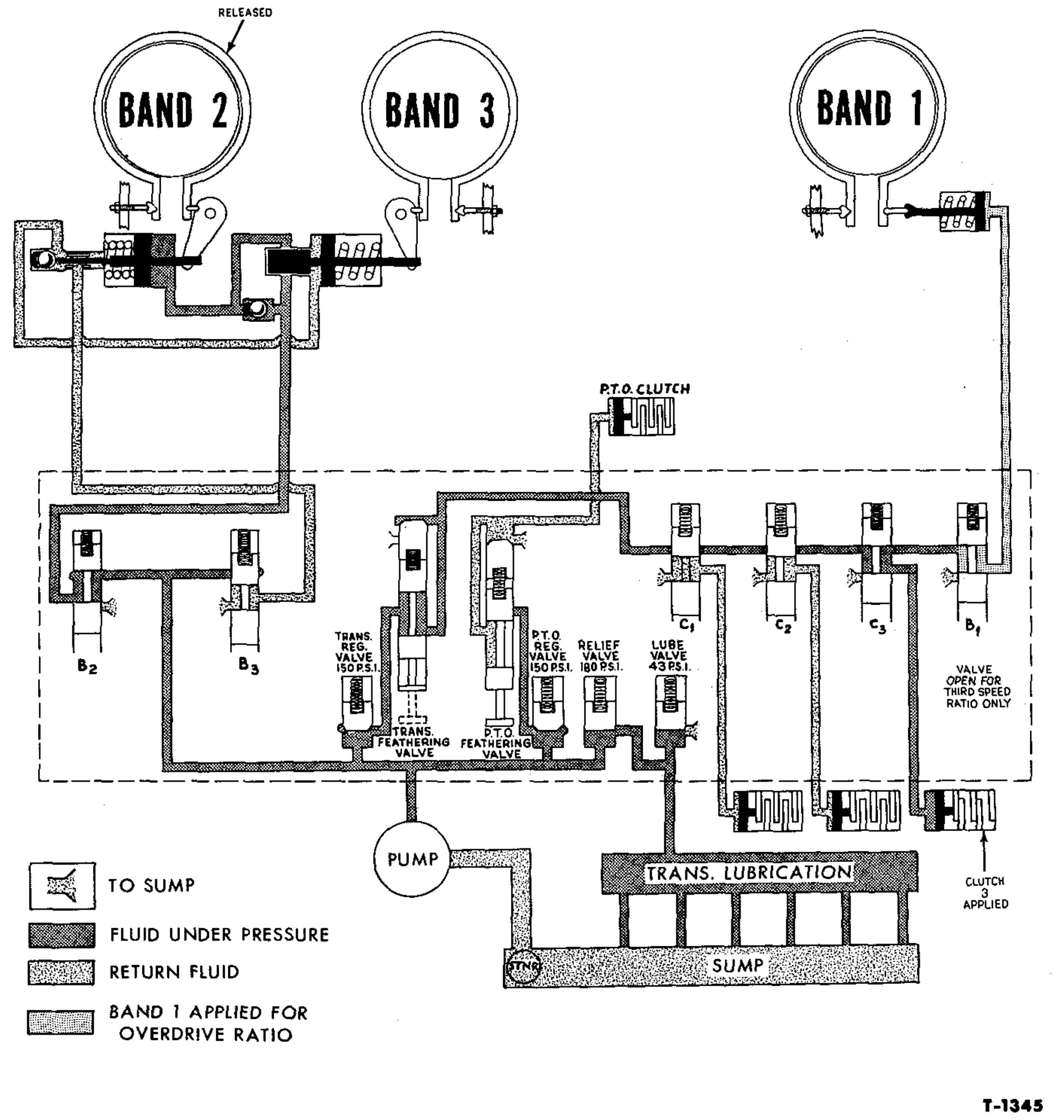


Figure 63—Hydraulic Control System—First and Third Speed Ratios

actuate these components and lubricate the transmission are explained, and control diagrams for all of the basic speed ratios are given, on the following pages.

Pressure Lubrication: During normal operation, the excess hydraulic fluid from the system relief valve is always directed to the lubrication valve in the control valve upper body and a portion of this fluid is delivered through a passage in the distributor to the transmission mainshaft. A constant pressure of approximately 43 psi is maintained in this area to provide

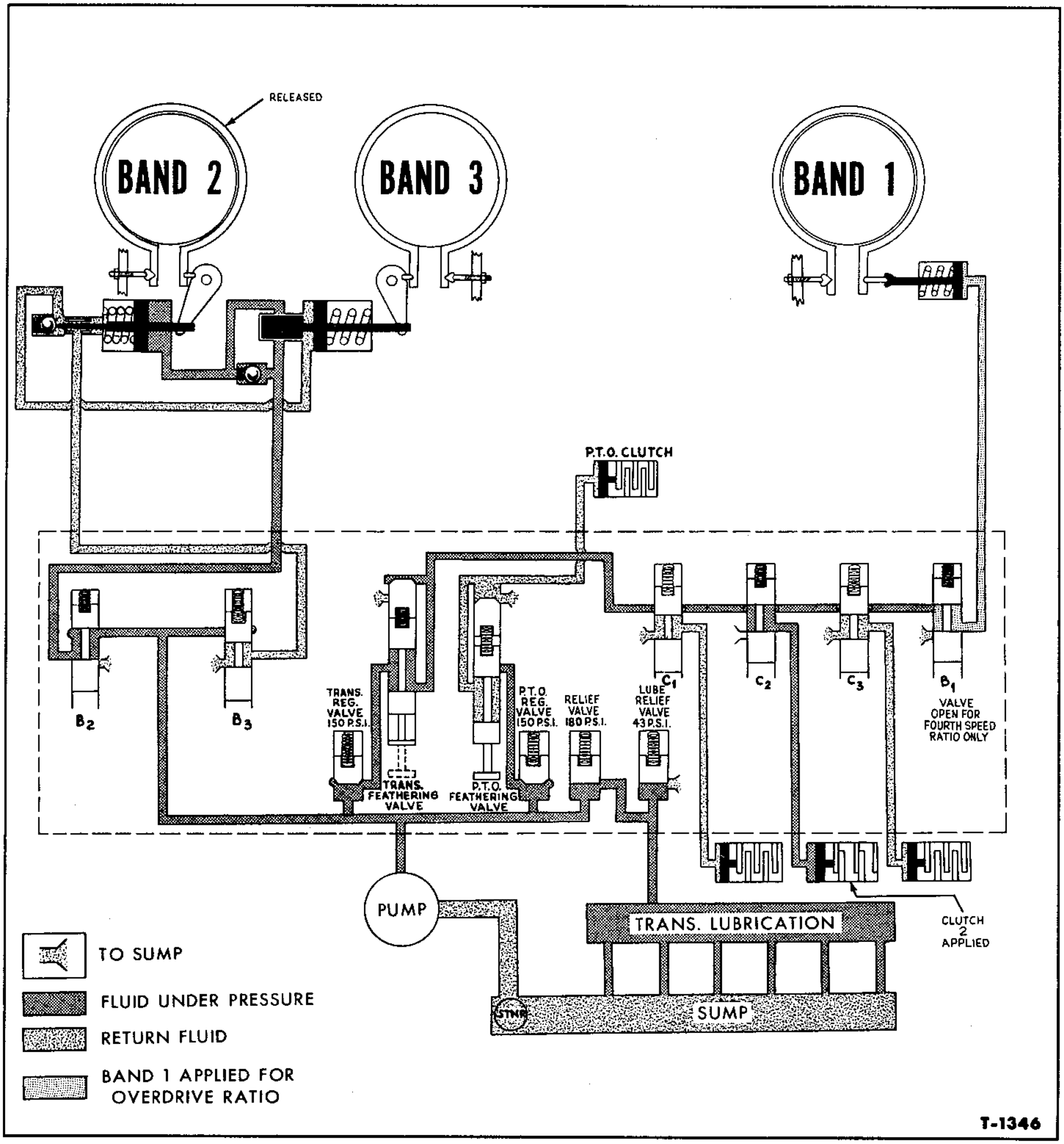


Figure 64—Hydraulic Control System—Second and Fourth Speed Ratios

positive lubrication through designed bleeding at specific locations. The rear of the mainshaft contains a plug with a small orifice to restrict the quantity of fluid going to the "D" carrier bearing.

A sender switch, shown in Figure 46, is installed in the rear support to light the lubrication indicator lamp on the instrument panel, shown in Figure 68, whenever lubrication fluid pressure is too low.

The lubrication indicator lamp will flash on whenever either of the feathering valves is used. This

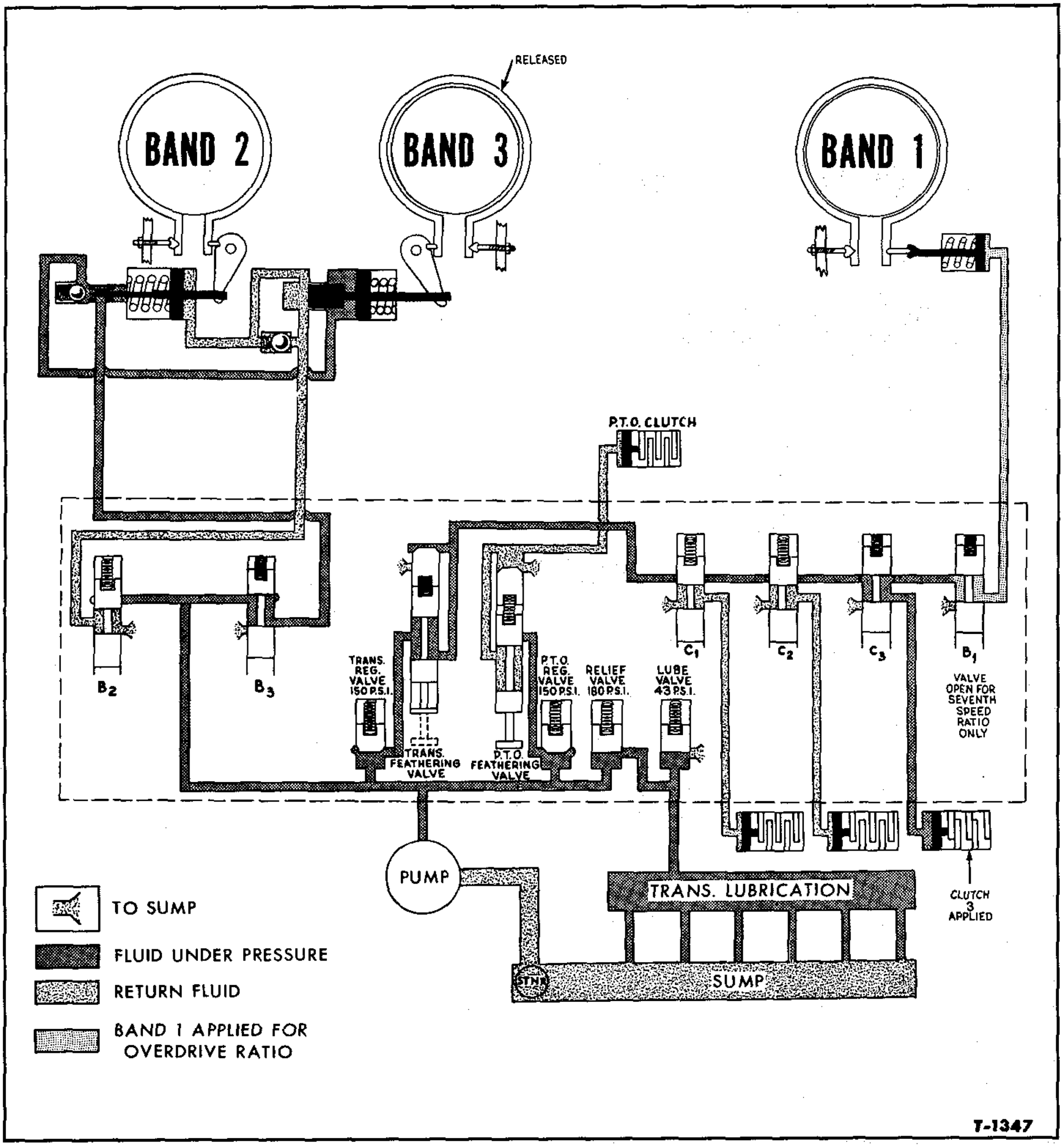


Figure 65—Hydraulic Control System—Fifth and Seventh Speed Ratios

momentary drop of lubrication pressure is not detrimental as the lubrication passages will continue to supply fluid as required for a short time. The lubrication indicator lamp and sender switch may be readily checked for proper operation with the ignition switch on and the tractor engine stopped.

Park Position: When the selector lever is in the (P) park position, the six spool-type valves in the control valve lower body are in the "OFF" position and there is no delivery of fluid pressure, other than lubrication,

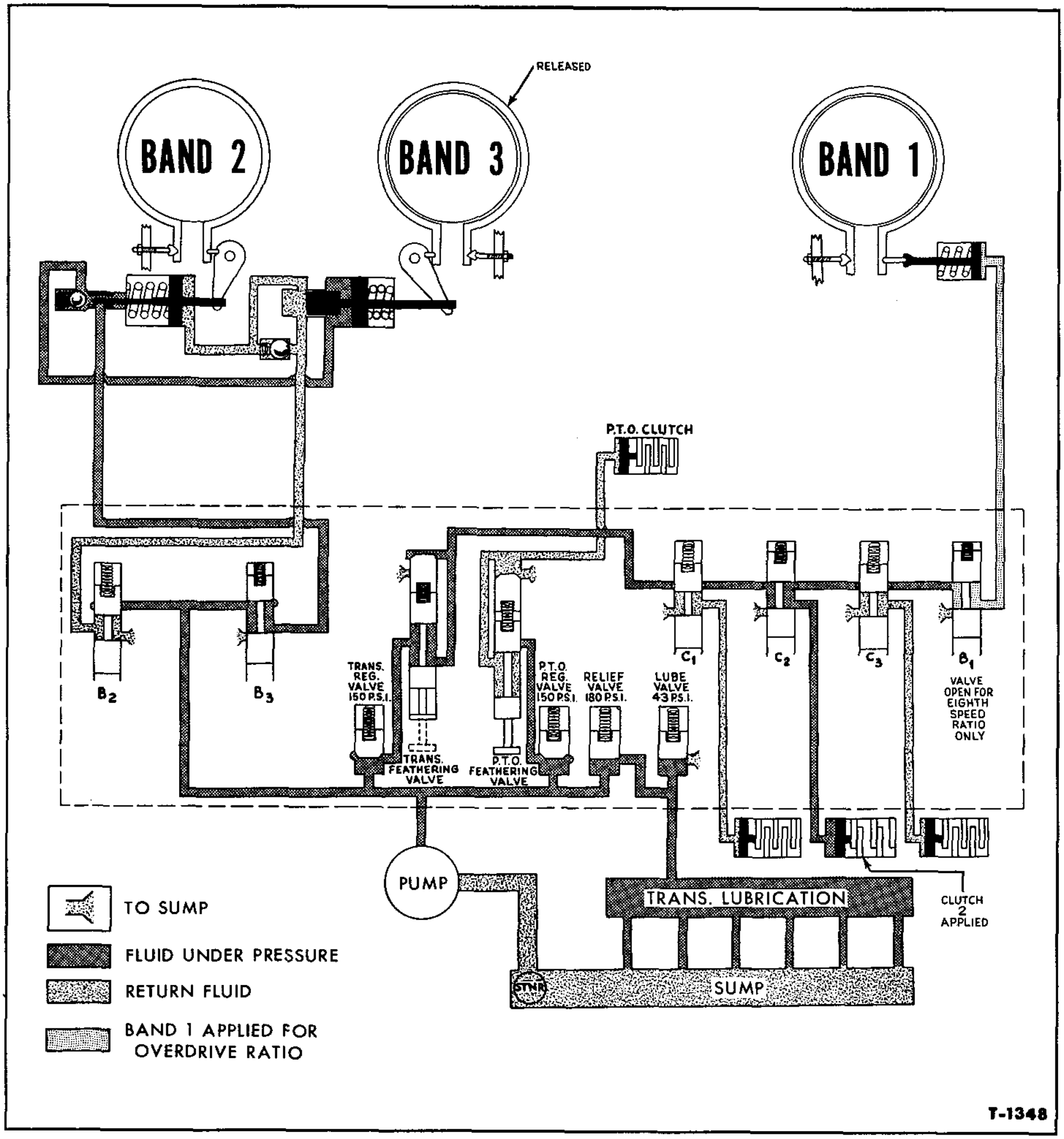


Figure 66—Hydraulic Control System—Sixth and Eighth Speed Ratios

to any of the components in the system, as shown in Figure 60. Bands 2 and 3 will remain mechanically applied to hold the "C" planetary system and prevent any movement of the rear wheels.

Reverse Speed Ratios: In the basic reverse speed ratio (R_1), the spool-type valves B_2 and C_1 are moved inward and fluid pressure is directed to apply clutch 1 and release band 2, as shown in Figure 61. Band 3 remains mechanically applied. The overdrive reverse ratio (R_2), is obtained when spool valve B_1 is also moved inward to open the passage from the control valve to servo 1, permitting fluid pressure to

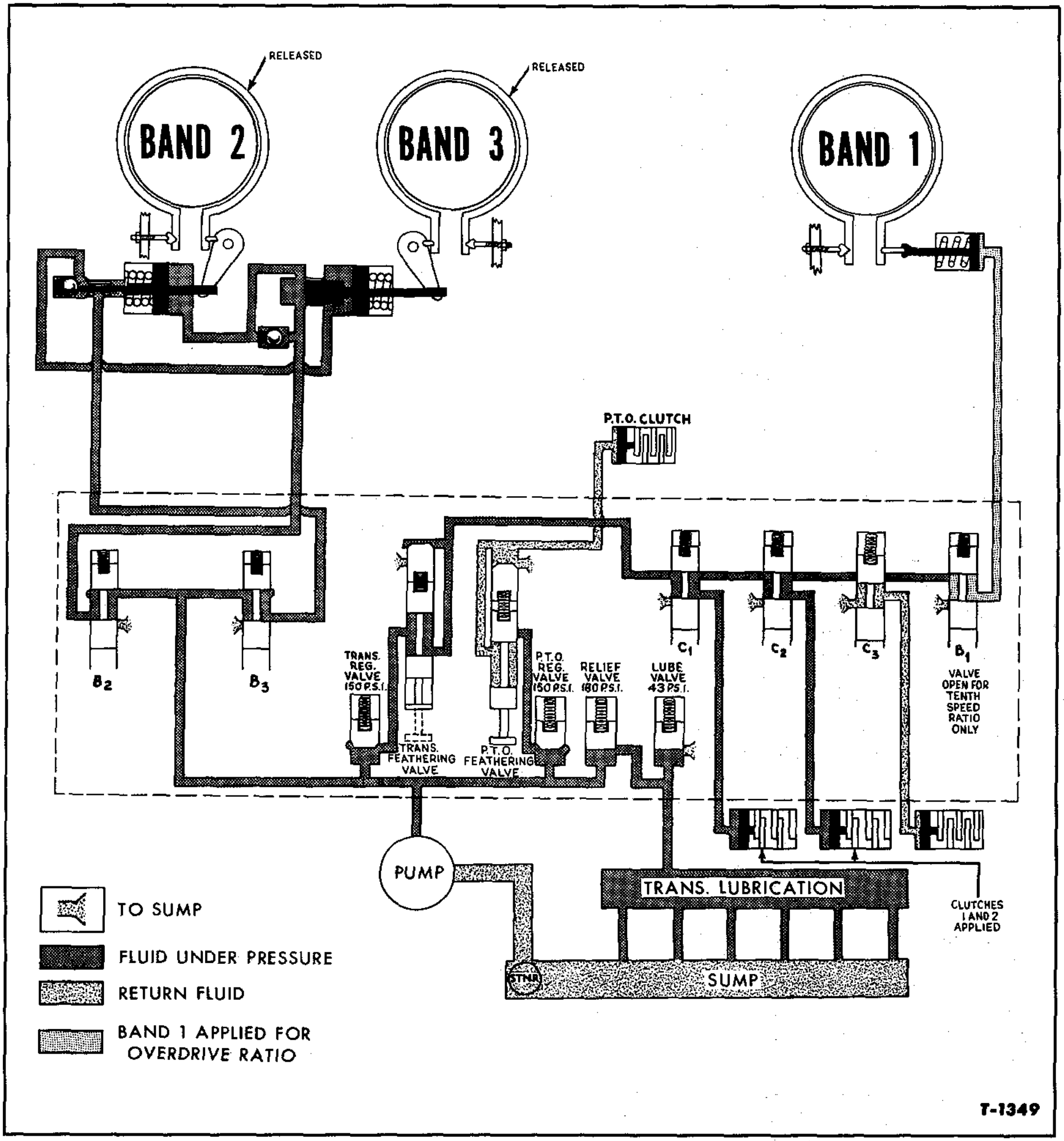


Figure 67—Hydraulic Control System—Ninth and Tenth Speed Ratios

apply band 1.

Neutral: With the selector lever in the neutral position, only the spool valve B_2 is moved inward. The fluid pressure is directed to servo 2 and band 2 is hydraulically released as shown in Figure 62. With only band 3 mechanically applied, power cannot be transmitted to the rear wheels, however, the tractor is free to roll forward or backward.

First and Third Speed Ratios: The first speed ratio is provided when the spool valves B_2 and C_3, which control the fluid passages to servo 2 and clutch piston 3 are moved inward, as shown in Figure 63. Hydraulic pressure releases band 2 and applies clutch 3 which, combined with band 3, being mechanically applied, gives this forward speed. The third speed ratio (overdrive of first speed) is obtained when the spool valve B_1 is moved inward to open the passage from the control valve to servo 1, permitting fluid pressure to apply band 1.

Second and Fourth Speed Ratios: The second speed ratio is provided as the spool valves B_2 annd C_2 are moved inward to permit hydraulic pressure to reach clutch piston 2 and servo 2, as shown in Figure 64. Band 2 is now hydraulically released. Clutch 2 is hydraulically engaged and band 3 is mechanically applied to establish this forward speed. The fourth speed ratio (overdrive of second speed) is obtained when spool valve B_1 is moved inward to open the passage from the control valve to servo 1, permitting fluid pressure to apply band 1.

Fifth and Seventh Speed Ratios: The fifth speed ratio is provided when spool valves B_3 and C_3 in the control valve lower body are moved inward to open the passages to clutch 3 and servo 3, as shown in Figure 65. Now band 3 is hydraulically released and band 2 is mechanically applied to combine with clutch 3 and give this forward speed. The seventh speed ratio (overdrive of fifth) is obtained when spool valve B_1 is moved inward to open the passage from the control valve to servo 1, permitting hydraulic pressure to apply band 1.

Sixth and Eighth Speed Ratios: The sixth speed ratio is provided when the spool valves B_3 and C_2 which control the passages to servo 3 and clutch piston 2 are moved inward, as shown in Figure 66. Band 3 is hydraulically released, clutch 2 is hydraulically applied, and band 2 is mechanically applied by the servo spring pressure, to obtain this forward speed. The eighth speed ratio (overdrive of sixth) is obtained when the spool valve B_1 is moved inward to open the passage from the control valve to servo 1, permitting hydraulic pressure to apply band 1.

Ninth and Tenth Speed Ratios: The ninth speed ratio is provided when four of the spool valves B_2, B_3, C_1, and C_2, are moved inward allowing hydraulic pressure to actuate servos 2 and 3, and clutch pistons 1 and 2, as shown in Figure 67. With bands 2 and 3 hydraulically released, this forward speed is obtained by the application of clutches 1 and 2. The tenth speed ratio (overdrive of ninth) is obtained when a fifth spool valve B_1 is moved inward to open the passage between the control valve and servo 1, permitting hydraulic pressure to apply band 1.

GEAR RATIO SELECTOR ASSEMBLY

The selector assembly, shown in Figure 68, mechanically transmits the speed selections, through a flexible cable, to the control valve in the Select-O-Speed Transmission. A wheel attached to the camshaft on the control valve rotates as the selector extends or retracts the cable. The camshaft is accurately indexed for each transmission ratio by a detent which engages notches in a detent cam on the camshaft.

As the selector is moved upward from the (P) park position, a wheel within the selector housing feeds cable through the conduit and transmission cover to a cable wheel on the control valve assembly. The selector cable wheel is held securely to a shaft which passes through the selector assembly and has a cover attached to either end. As the speeds are changed by repositioning the spring-loaded lever, the lever actuates the notched cover which, in turn, rotates the shaft. The lever itself does not actuate the shaft, as a loose fit on the shaft is necessary to permit the lever to be moved outward when changing from the neutral position or to bypass pre-set speed stops. The control lever and notched cover may be installed on either side of the selector shaft.

A lamp is installed in the top of the selector assembly which provides illumination on the selector dial whenever the tractor key is turned "ON." The light will assist in viewing the speed selections and their corresponding ground speeds shown in mph for 1200, 1750, and 2200 engine rpm.

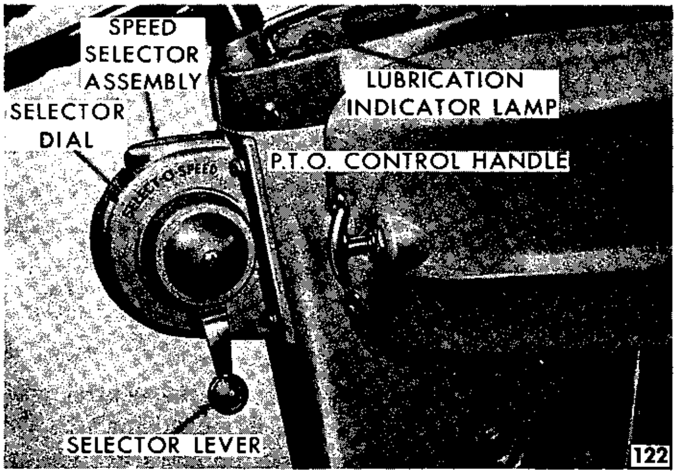


Figure 68—Speed Selector Assembly

8. MAINTENANCE AND ADJUSTMENTS—SELECT-O-SPEED TRANSMISSION

The Select-O-Speed Transmissions are filled at the factory with Ford Hydraulic Fluid, Specification M 2C41. Always use this type when adding or changing fluid, as the use of improper or inferior hydraulic fluid may affect the operation of the transmission.

MAINTENANCE

A. Transmission Fluid Level Check

The fluid level in the Select-O-Speed Transmission should be checked during the pre-delivery servicing and at 50 hour intervals thereafter, using the following procedure.

1. Make certain that the tractor is standing level.
2. Shut off the tractor engine.
3. Clean the area surrounding the fluid level and filler plug, shown in Figure 72, and remove the plug.
4. Check to be sure that the fluid is up to the level of the filler plug opening. If necessary, add enough fluid through this opening to provide the proper level, and replace the plug.

B. Transmission Fluid Change

It is important that the transmission fluid and filter be changed at the 50 hour inspection and at 1200 hour intervals thereafter. It is also recommended that the fluid be changed whenever foreign material is found in, or is known to have entered the transmission. New fluid, Ford Specification M 2C41, should always be installed whenever the transmission has been disassembled for servicing.

The following procedure should be followed when changing the transmission hydraulic fluid. For filter replacement refer to Page 247 of this manual.

1. Loosen the hex head bolt, shown in Figure 69, which secures the drain plug and screen assembly in the interlock cover by means of a retainer.
2. Remove the plug sufficiently to expose the "O" ring, then rotate this assembly 180°. The fluid will now be directed straight down as the plug and screen are moved farther out.

   NOTE: ***It may be necessary to thread a ¼"-20 bolt into the plug to provide a means of initially withdrawing this assembly.***

3. Drain the fluid from the transmission, then completely remove and thoroughly clean the screen. Discard the "O" ring.

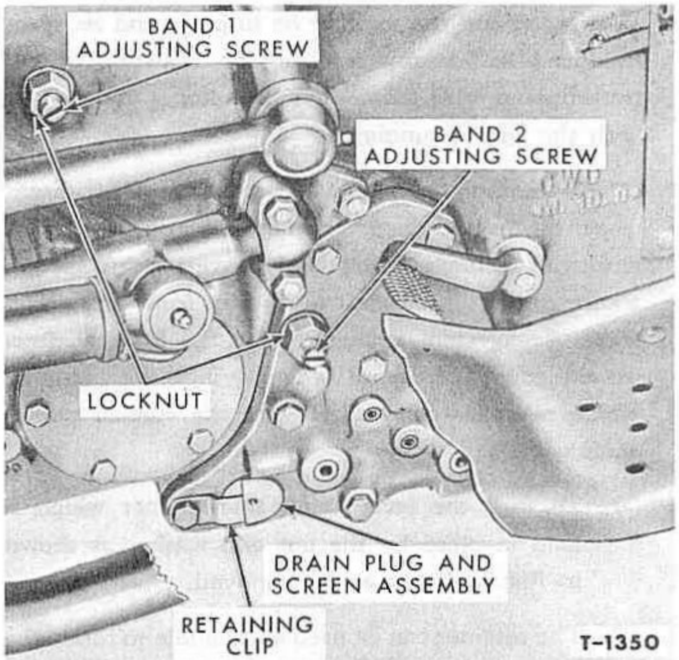


Figure 69—Select-O-Speed Transmission—Left Side

4. Place a new "O" ring on the plug, install the screen and plug in the interlock cover with the hole to the top and secure with the retainer and hex head cap screw.
5. Clean the area surrounding the fluid level and filler plug, then remove the plug and add 11.5 quarts of Ford Specification M 2C41 Hydraulic Fluid to the transmission through this opening.

   NOTE: ***If the transmission cover has been removed, the fluid can be easily installed through this larger opening.***

6. Replace the fluid level and filler plug. Run the engine at a fast idle speed to bring the fluid up to normal operating temperature.
7. With the traction coupling locked in the disengaged position, shift the selector lever through all speeds. Stop the engine and check the fluid level.

ADJUSTMENTS

A. Traction Coupling

All tractors equipped with a Select-O-Speed Transmission incorporate a coupling sleeve which can be shifted to disengage the power from the differential pinion shaft. It will be necessary to disengage the traction coupling whenever the tractor is to be moved without the engine running as bands 2 and 3 will be mechanically applied to hold the rear wheels. *It is also recommended that the traction coupling be disengaged and the retainer be in place* and securely tightened before any servicing or adjusting of the transmission or of the complete tractor is undertaken with the engine running.

The traction coupling sleeve is manually disengaged by turning the lever shaft, shown in Figure 70, clockwise to move the splined sleeve forward on the transmission output shaft and away from the pinion shaft. Engagement is made when the lever shaft is turned counterclockwise which brings the coupling sleeve rearward to connect with the splined pinion shaft.

1. To turn the lever shaft, the retainer which is held in place by the nut and washer as shown in Figure 70, must be removed.
2. The retainer can be used as a handle to rotate the shaft in the desired direction. There are alternate positions for installing the retainer in the engaged or disengaged positions of the coupling sleeve.
3. If the retainer does not align properly, turn it both end for end and side for side.

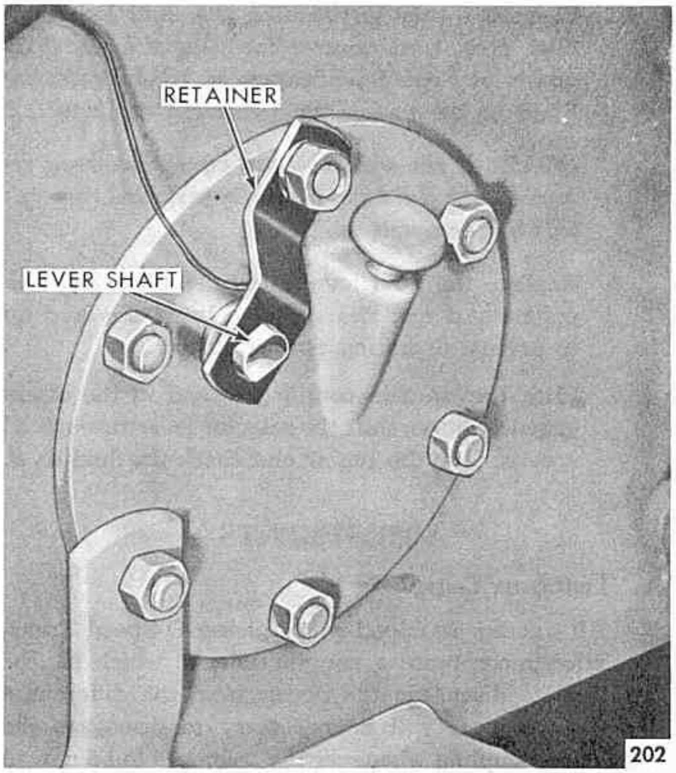


Figure 70—Traction Coupling Disengaged

B. Band Adjustments

The three brake bands in the Select-O-Speed Transmission should be adjusted during the pre-delivery servicing and again at the 50 hour inspection. Thereafter, the bands should need attention only in conjunction with other transmission servicing, or after each 600 hours of operation. Before adjusting the bands, make certain that the tractor engine is in good operating condition and that the fluid in the transmission is at the proper level. The bands are all adjusted in their released position as follows:

1. Disconnect the traction coupling making sure it is properly secured in the disengaged position.
2. Operate the tractor until the transmission reaches normal operating temperature (120° F.) and then adjust the throttle to obtain 800 engine rpm.
3. Hold the band adjusting screw as shown in Figure 71, and loosen the lock nut two full turns.
4. Referring to the chart, select the correct released gear ratio for the band involved. Tighten the adjusting screw to 5-10 ft. lbs. and back the screw off the proper number of turns. Refer to Figure 72.

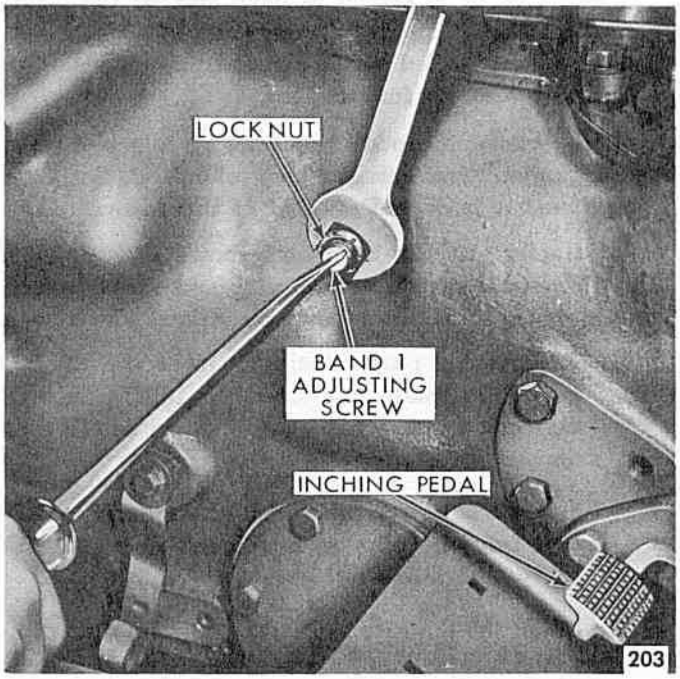


Figure 71—Loosening the Adjusting Screw Locknut

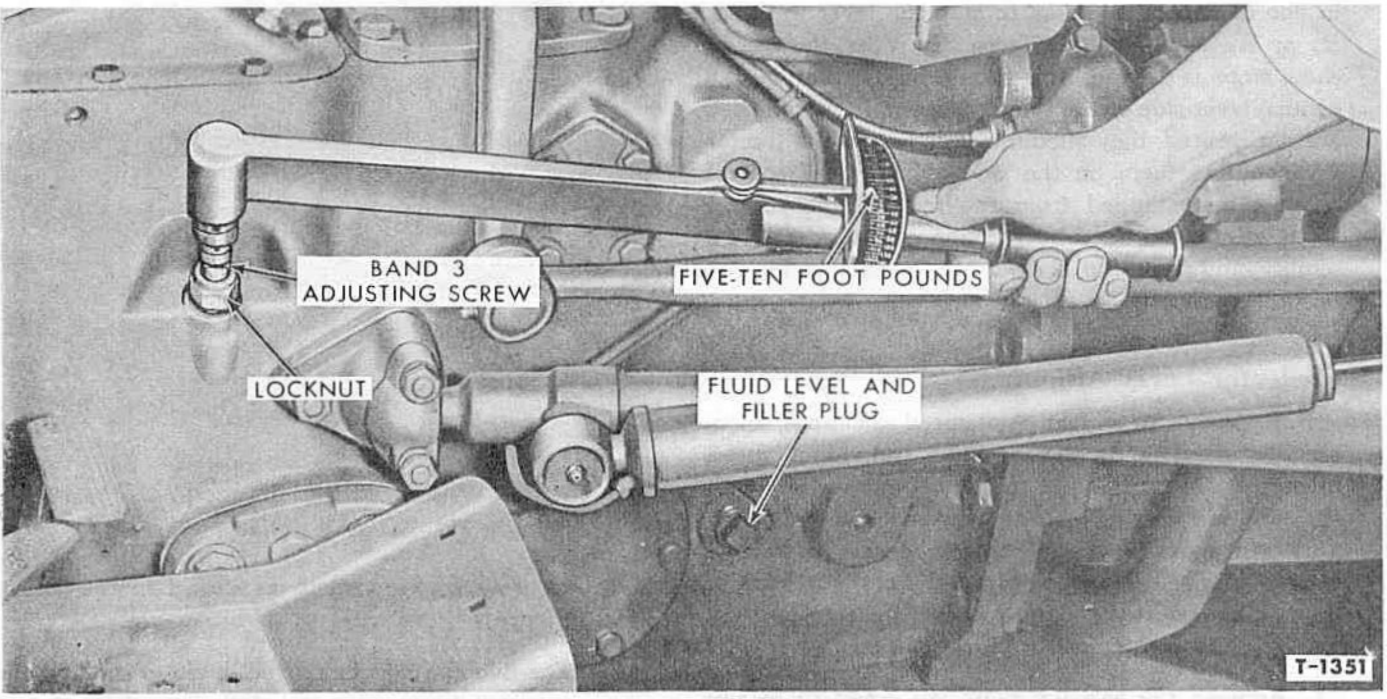


Figure 72—Adjusting the Bands

Band	Released Gear Ratio	Screw Torque (ft. lb.)	Turns Backed Off	Applied Gear Ratio
1	Neutral	5-10	1	3rd
2	Neutral	5-10	¾	Park
3	5th	5-10	¾	Park

5. Select a gear ratio to apply the band involved and prevent the adjusting screw from turning. Tighten the lock nut to 20-25 ft. lbs.

   NOTE: ***Overtightening the lock nut will distort the copper sealing washer.***

C. Repositioning the Selector Lever

In the event it is more convenient for the operator to make the speed selections with his left hand rather than his right hand, the lever may be repositioned as follows:

1. Remove the notched cover and spring from the right end of the selector shaft and the solid cover from the left end.
2. Move the control lever to the left end, as shown in Figure 73, and secure with the notched cover and spring.
3. Install the solid cover on the right end of the shaft.

D. Pre-Set Selections

Some operations will require a limited range of transmission speed ratios and often they will alternate between forward and reverse speeds. Therefore, five tapped holes have been incorporated in both sides of the selector housing which accommodate two stop screws, as shown in Figure 73. The screws can be placed in one of three specific holes which will stop the selector lever at third, fifth or seventh speed, and

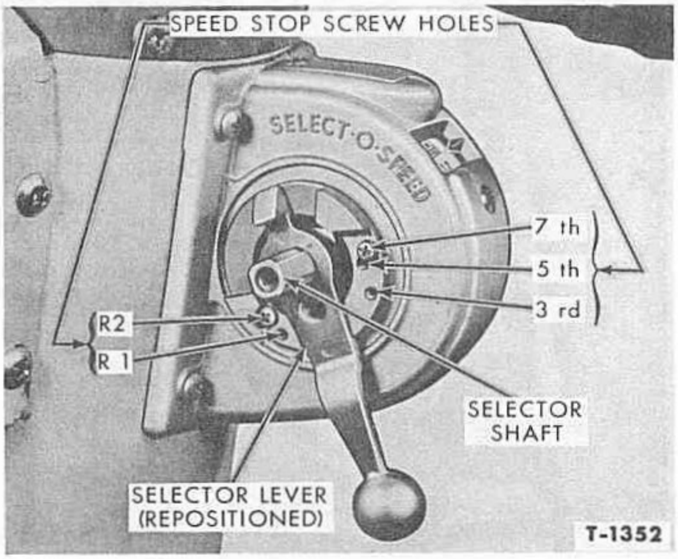


Figure 73—Repositioning the Selector Lever

in one of two other holes, to stop the lever in either R_1 or R_2, as shown in Figure 73. When the use of these stops is desired, they should be installed on the control lever side of the selector assembly. When they are not desired, they should be carried on the tractor by installing them on the side opposite the control lever. When shipped from the factory, the control lever is installed on the right side of the selector assembly and the stop screws are carried under the selector shaft left cover.

E. Selector Lever Alignment

For positive identification of speed selections, selector alignment is important. The individual speed identifications on the dial should always register with the pointers in the selector housing. The following ajustment makes it possible to compensate for normal wear in the selector assembly and for slight wear of the flexible selector cable, which will tend to position the dial indicator below or above the pointers.

1. Remove the selector shaft left cover to expose the shaft and hex nut as shown in Figure 74.

   NOTE: ***If the selector lever is on the left side, remove it and mount it on the right side while making the adjustment.***

2. Move the selector lever to the neutral position and, with a suitable wrench, such as a deep well socket, loosen the nut while holding the lever securely in the detent, as shown in the insert, Figure 74.

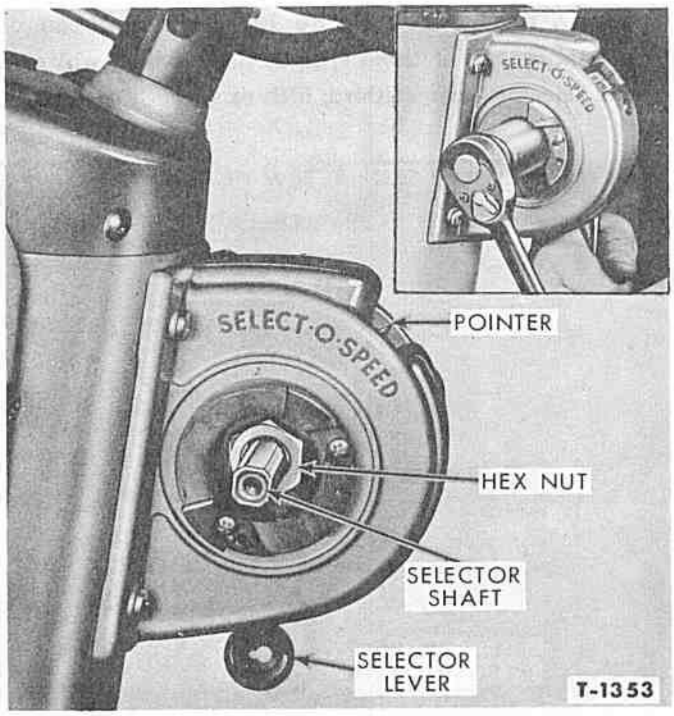


Figure 74—Alignment of the Selector Assembly

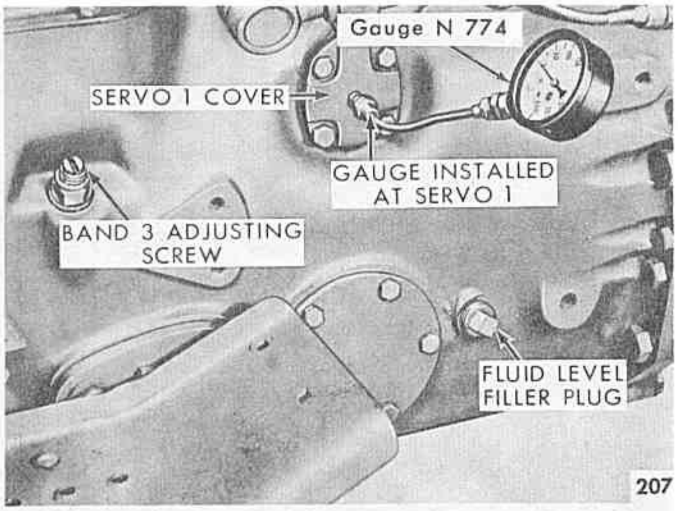


Figure 75—Gauge Installed in Servo 1

3. The dial can now be moved in either direction as required to register the dial with the pointers without changing the relationship of the flexible cable with the control valve assembly.

4. With the dial in the proper position, hold the lever and tighten the hex nut to 25-35 ft. lbs.

5. Check for proper dial registration adjustment in all speed selections and replace the shaft cover.

F. Control Valve

Proper transmission performance is dependent upon the functioning of the control valve, therefore, it is essential that the control valve be adjusted correctly. In order to adjust the control valve it is first necessary to pressure check the system to have some basis from which to start.

Checking System Pressures: The four plunger type relief and regulating valves in the control valve upper body, shown in Figure 57, control the fluid pressures within the system. Pressure readings taken at servos 1, 2 and 3, will indicate the exact setting of the system relief valve and the transmission and P.T.O. regulating valves when properly interpreted.

NOTE: ***Pressure in the complete system can be checked and the relief and regulating valves can be adjusted by the use of one gauge. However, the installation of three fluid pressure gauges, each one with a maximum range of from 250 to 400 psi. will present a complete listing of pressure readings in every speed ratio with just one check at each speed.***

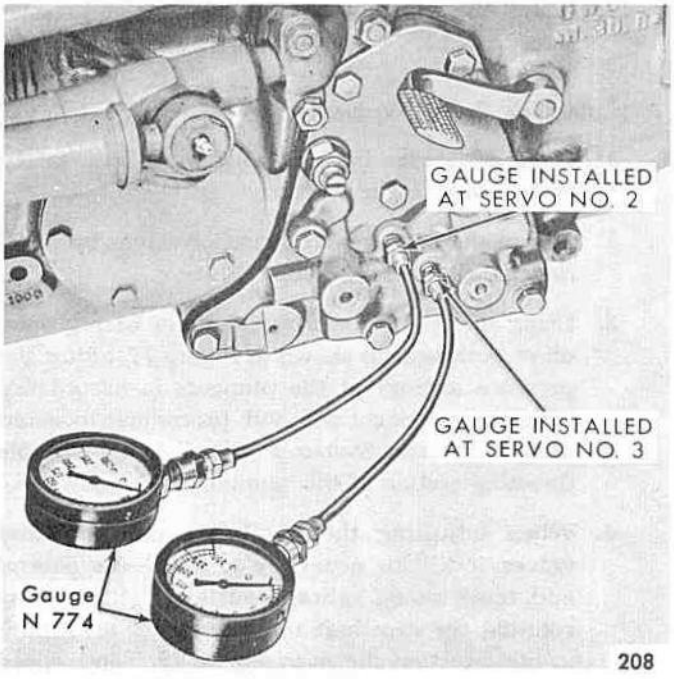

GAUGE INSTALLED AT SERVO NO. 2
GAUGE INSTALLED AT SERVO NO. 3
Gauge N 774
208

Figure 76—Gauges Installed in Servos 2 and 3

To check these valves, proceed as follows:

CAUTION: BEFORE STARTING TO CHECK PRESSURES, BE CERTAIN THE COUPLING IS LOCKED IN THE DISENGAGED POSITION.

1. Remove the plugs from the servo 1 cover on the right side of the transmission and the interlock cover on the left side and install the pressure gauges, as shown in Figures 75 and 76, using suitable fittings and tubing.
2. Start the tractor engine and run it at a fast idle to bring the transmission fluid temperature up to 120° F. When the fluid is warm, slow the engine down to 800 rpm.
3. Shift the selector lever to each speed and check the pressure at the three locations as fluid pressure is directed to the servos. If all of the readings are 180± 10 psi, the system relief valve is functioning properly. If higher or lower readings are obtained, the relief valve will have to be adjusted as outlined on Page 222.

   NOTE: ***If a difference in readings of more than 3 psi are noted between servos, a pressure leak is indicated. Refer to Trouble Shooting, Page 249.***

4. Shift the selector lever to neutral and partially depress the inching pedal (P.T.O. handle in). The transmission feathering valve in the control valve lower body will bleed off system pressure and the transmission regulating valve will function to maintain 150 ± 5 psi in the direct transmission circuit. If the lubrication indicator lamp should flash on and pressure at servo 2 should be approximately 150 ± 5 psi, the transmission regulating valve will have to be adjusted as outlined on Page 222.
5. Shift the selector lever to tenth speed to direct fluid pressure to all three servos. Partially engage the P.T.O. clutch by pulling the P.T.O. control handle to its midway position. The P.TO. feathering valve in the control valve lower body will tend to bleed off system pressure and both regulating valves will function to maintain 150 ± 5 psi in the direct transmission circuit, including servos 2 and 3, and in the indirect transmission circuit, including the transmission clutches and servo 1. The lubrication indicator lamp should flash on and pressure at servos 1, 2, and 3 should be approximately 150 ± 5 psi. If the pressure readings are higher or lower than 150 ± 5 psi, and the transmission regulating valve is known to be functioning properly, the P.T.O. regulating valve will have to be adjusted as outlined on Page 222.
6. If the lubrication indicator lamp has reacted normally during the preceding checks, showing a loss of transmission lubrication whenever the system pressure dropped below 180 ± 10 psi, it is safe to assume that the lubrication pressure valve is functioning properly. If the indicator lamp should remain lighted when the pressures are normal, the lubrication pressure valve will have to be adjusted as outlined on Page 222. If the valve is adjusted to its maximum pressure and the indicator light remains lighted, refer to the Trouble Shooting Section on Page 249 for possible low lube pressure causes.
7. In some cases where malfunctioning in the lube circuit or sender switch is thought to exist, it may be desirable to check lube pressure. This may be accomplished in the following manner.
   a. Remove the traction coupling disconnect cover, by first loosening or removing left step plate.
   b. Remove the lube light wire from the sender switch by pulling the wire from the switch terminal.
   c. Remove the sender switch from the rear support by unscrewing it with a wrench, and install a brass elbow (⅛″ pipe thread x ⅜″ flare) into the ⅛″ pipe thread in the rear support.
   d. Attach pressure gauge and line.

NOTE: ***To accurately check pressure at this point, use a 15 to 30 pound gauge. Lube pressure at 800 engine rpm should be 2 psi minimum in all speeds and a maximum of 12 psi.***

Removing and Installing the Control Valve for Adjustment: After it has been determined that one or more of the plunger type relief or regulating valves in the control valve upper body require adjustment, proceed as follows:

1. Remove the transmission cover as outlined on Page 225 of this manual.

   IMPORTANT: ***Before the cover is removed from the transmission, check to be sure that all of the screws, bolts, and tools have been set aside and are not in a position where they might fall into the transmission case, and that the cover and surrounding areas are completely clean.***

2. Remove the starter safety switch and oil discharge tube or oil filter from the control valve.
3. Remove the mounting bolts securing the valve body assembly to the distributor.

   IMPORTANT: ***Do not loosen the three bolts which hold the two halves of the control valve body together.***

4. Depress the inching pedal and remove the valve body assembly using care not to lose the gasket.
5. Remove the adjusting screw from each retainer located near the top of the valve body.
6. Install the valve assembly on the distributor and attach the oil discharge tube or filter to the valve.
7. Adjust the control valve as outlined below.
8. When the individual valve or valves have been properly adjusted, remove the control valve from the distributor and secure the adjusting screws with the two retainers.

   NOTE: ***If the retainers do not align with the slots in the screws, turn the screw or screws inward, until alignment is possible.***

9. Install the valve body assembly and tighten the six mounting bolts to 6-8 ft. lbs.
10. Turn the camshaft so that the valve body is in the Park (P) position. (All of the spool valves out).
11. Install the oil discharge tube or filter and starter safety switch.

Adjusting the Control Valve:

1. Start the engine by grounding the starter safety switch wire to the tractor.
2. Locate the correct plunger relief valves by referring to Figure 57.
3. Using an offset screwdriver, that has been ground off at both ends as shown in Figure 77, adjust the pressure settings of the plungers in accordance with the specifications and procedures covered under "Checking System Pressure" in the Trouble Shooting section of this manual.
4. When adjusting the regulating plunger relief valves, it will be necessary to locate the neutral and tenth speed ratios. Neutral is obtained by rotating the camshaft three positions from park in the direction shown in Figure 77. Tenth speed is located one position in the opposite direction from park.

   NOTE: ***If any of the plungers have been removed, the initial setting should be made with the head of the adjusting screw flush with the valve body.***

5. When the individual valve or valves have been properly adjusted, remove the control valve from the distributor and secure the adjusting screws with two retainers. If the retainers do not align with the slots in the screws, turn the screw or screws inward, until alignment is possible.

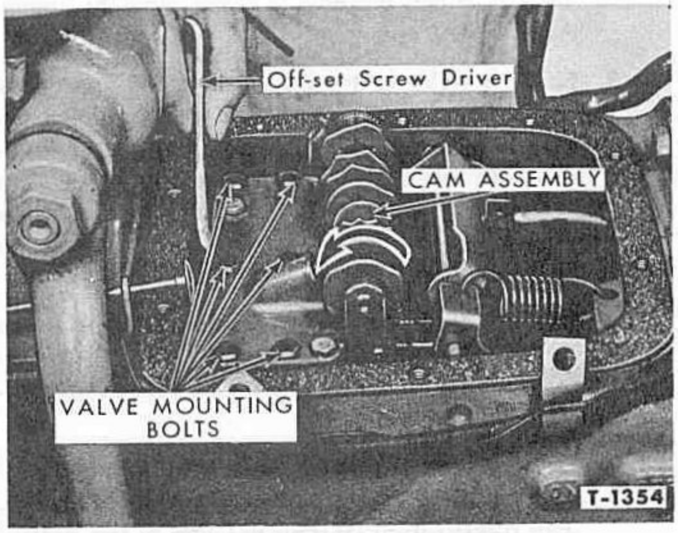


Figure 77—Adjusting the Control Valve

IMPORTANT: *This work must always be done with clean tools in a completely clean area. Any entry of dirt or other foreign matter may result in serious damage to the transmission.*

Valve Body Alignment: If any time the valve upper and lower bodies have been replaced, it will be necessary to align the valve body. Correct alignment is necessary to provide uniform shifting characteristics.

Valve alignment is checked by moving the camshaft to the "Park" position and inserting a feeler gauge between the spool land and the side of the discharge port in the lower body, as shown in Figure 78. The clearance should be 0.057 ± 0.010 inch. To adjust, loosen the three retaining bolts and shift the bodies as required to obtain the proper clearance. If necessary, the holes in the valve upper body may be drilled oversize to achieve the correct clearance. Rescribe the sides of the bodies to eliminate the need for this procedure during any future servicing of the valve body.

G. Adjusting the P.T.O. Interlock—Model 81

To prevent engaging both the ground speed P.T.O. and the engine P.T.O. at the same time, an interlock is provided, Figure 79. The interlock consists of a flexible cable, enclosed in a conduit joining the actuating lever for the P.T.O. feathering valve and the ground speed P.T.O. lever through a plunger and bracket arrangement.

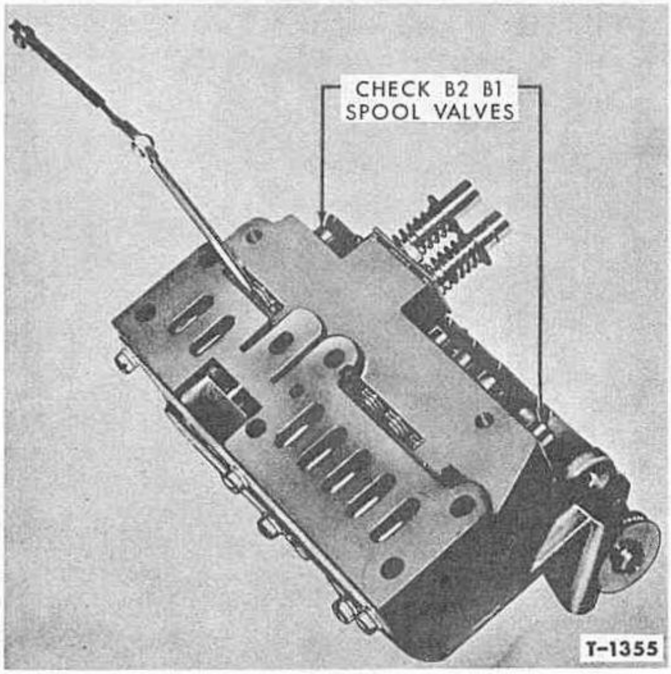


Figure 78—Valve Body Alignment

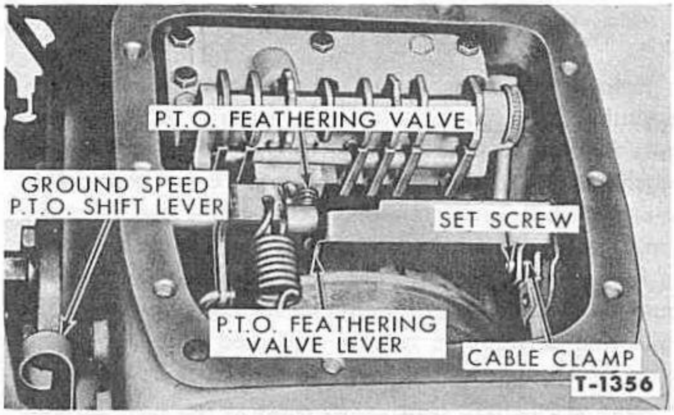


Figure 79—Adjusting the P.T.O. Interlock—Model 81

With the P.T.O. clutch disengaged, the cable is completely extended through to the P.T.O. lever so that the plunger is below the forked bracket. When the ground speed lever is moved forward, the plunger will move to surround the cable. In this position, the plunger cannot be raised by the cable to engage the engine P.T.O. clutch.

When the P.T.O. clutch is engaged, the cable is pulled up so that the feathering valve lever depresses the valve spool further into its bore in the valve body. In this position, the plunger lies in the path of the forked bracket so that the ground speed P.T.O. cannot be engaged.

Adjust the interlock mechanism as follows:

1. Remove the transmission cover.
2. Position the ground speed shift lever in the forward notch to engage the ground speed P.T.O.
3. Loosen the set screw in the cable clamp, shown in Figure 79, and position the feathering valve with the valve in the "OUT" position.
4. Pull all excess cable through the clamp and secure the cable with the set screw.

Make sure the lever cannot move the valve by pulling up on the P.T.O. control cable connector with the ground speed P.T.O. engaged. Disengage the ground speed P.T.O. and pull up on the P.T.O. control cable connector to depress the feathering valve. Now check to be certain the ground speed P.T.O. cannot be engaged.

9. TRANSMISSION OVERHAUL

Before removing any of the transmission subassemblies, thoroughly clean the exterior of the transmission case to prevent dirt from entering the various mechanisms. If the transmission is to be completely overhauled, it is recommended that the transmission be removed from the tractor and placed in a stand, as shown in Figure 80. However, since it is desirable to service the unit with a minimum amount of disassembly work, the following procedures can be followed with the transmission in the tractor, split at the front or the rear.

With the tractor split at the front of the transmission, the following components can be serviced:

Front Pump and Gasket
Adapter Plate and Gasket
Main Oil Supply Line and "O" Rings
P.T.O. Shaft Preload
Front Pump Cover "O" Ring
Front P.T.O. Shaft Seal
Servo 1 Line and "O" Rings
Torque Limiting Clutch

With the tractor split at the rear of the transmission, all components up to the input shaft can be serviced using the same procedures as with the transmission removed. The following components can only be serviced with the transmission completely removed from the tractor:

Input Shaft including Bearings and Gears
P.T.O. Front Shaft and Clutch Pack, Bearings and Shaft Seals
Engine P.T.O. Shifter components
P.T.O. Shift Linkage

The control valve, oil filter, and Servo Piston "O" Rings can be serviced with the transmission in the tractor.

It is essential that all of the disassembly of the transmission be done in clean surroundings with clean tools and that all servicing of removed parts be done on new paper. All wiping of hands and parts should be done with a clean chamois or lint-free wiper. The presence of lint in the transmission, as well as any other foreign material, may result in serious damage.

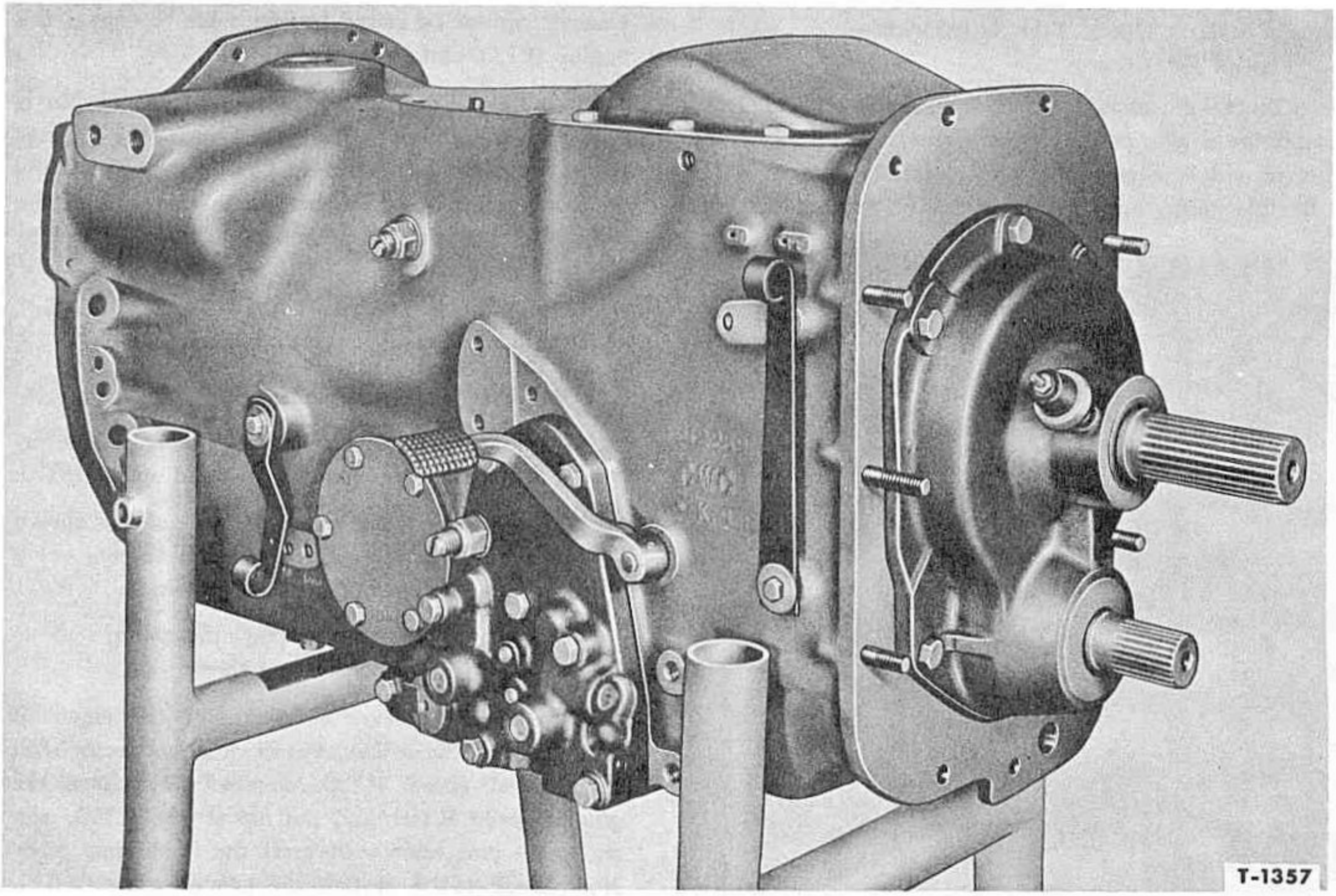

T-1357

Figure 80—Transmission Mounted in Stand

NOTE: *All of the disassembly, servicing, and assembly procedures described and illustrated in this chapter relate specifically to the Model 81 Select-O-Speed Transmission; however, a special notation will follow any steps which may require additional information or clarification to properly service Model 71 transmissions. When servicing Model 11 transmissions, disregard all references to the P.T.O. systems and their components.*

REMOVAL OF SUB-ASSEMBLIES

A. Transmission Cover

1. Completely loosen the conduit nut that attaches the selector cable conduit to the transmission cover, being careful not to allow the lower nut to turn.
2. Remove the four Phillips head screws that attach the selector assembly to the tractor hood.
3. Move the selector lever upward to tenth speed, and disconnect the upper selector cable from the lower cable. Disconnect the selector lamp wire, at the connector as shown in Figure 81. The selector assembly can now be removed from the tractor.

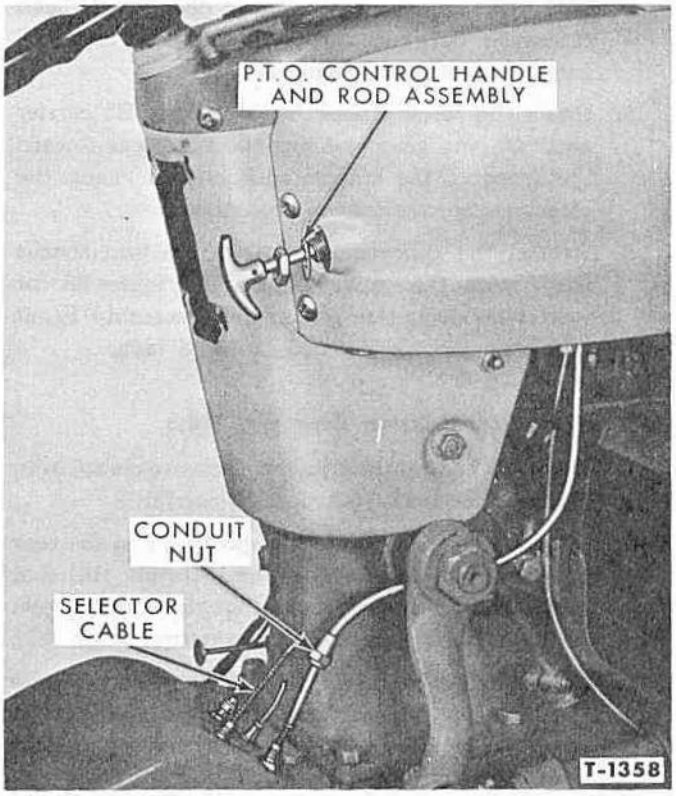


Figure 81—Removing the P.T.O. Control Assembly—Models 71 and 81

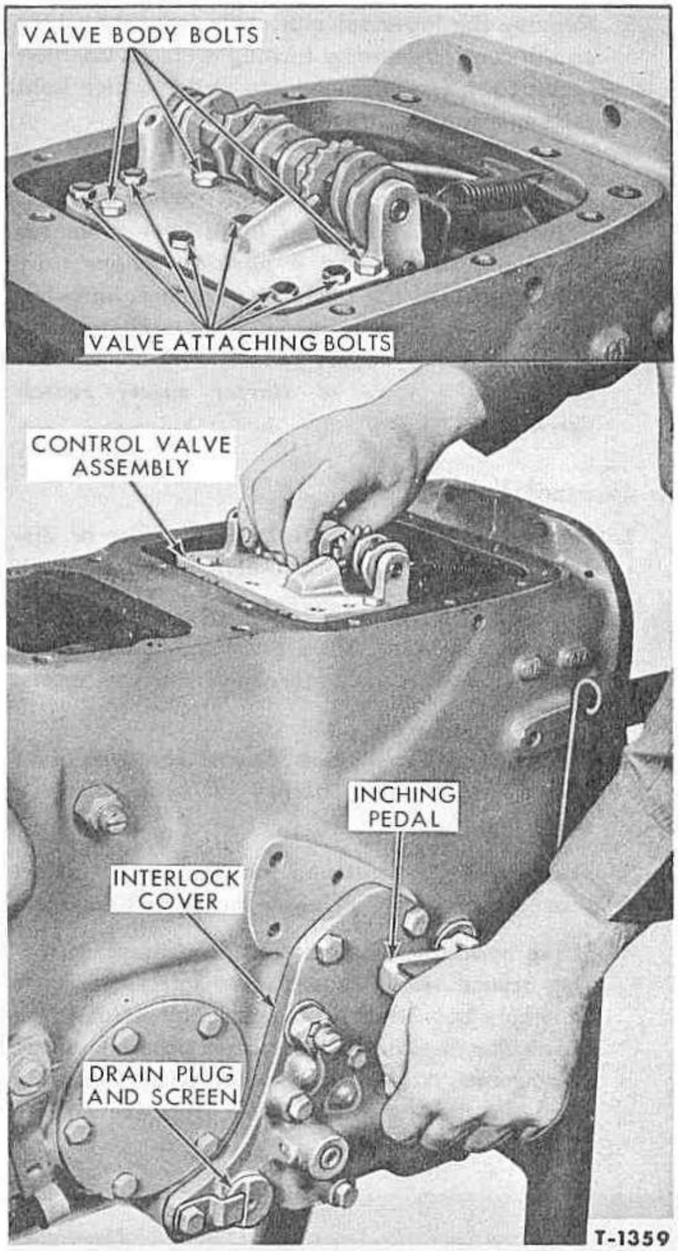


Figure 82—Removing the Control Valve Body

4. On Model 71 and 81 transmissions, it will also be necessary to pull the P.T.O. control handle all the way out and completely loosen the conduit nut that attaches the P.T.O. cable conduit to the transmission cover, as shown in Figure 81, being careful not to let the lower nut turn. After the jam nut, shown in Figure 81, has been loosened, the control unit can be turned clockwise to thread the flexible cable out of the P.T.O. connector in the transmission. Turn the control unit and maintain a slight pull on the exposed cable just above the cover until the cable comes out of the cover.

5. Remove the lower selector cable from the wheel on the control valve by turning it clockwise, then remove the ten hex head cap screws which hold the cover in place.

   IMPORTANT: *Before the cover is removed from the transmission, make certain that all of the screws, bolts and tools have been set aside and are not in a position where they might fall into the transmission case, and that the cover and surrounding area are completely clean. Lift the cover, loosen screw and disconnect the wire to starter safety switch assembly.*

B. Control Valve

1. Remove the bolts that attach the filter or discharge tube to the control valve and remove the filter or tube.
2. Remove the bolts that attach the control valve body to the distributor shown in the insert, Figure 82.

   IMPORTANT: *Do not loosen the three bolts which hold the two halves of the control valve body together.*

3. Depress the transmission inching pedal and remove the control valve, as shown in Figure 82.
4. If the hydraulic fluid has not been drained from the transmission, loosen the interlock cover attaching bolt which holds the retainer over the drain plug and screen assembly. Loosen the drain plug, rotate it 180° and withdraw the assembly until the fluid will flow freely from the hole in the bottom of the plug.

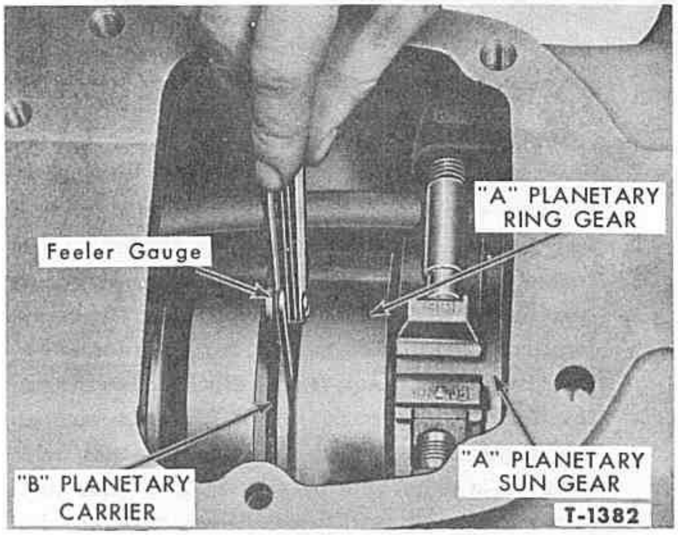


Figure 83—Checking Transmission Front End Play

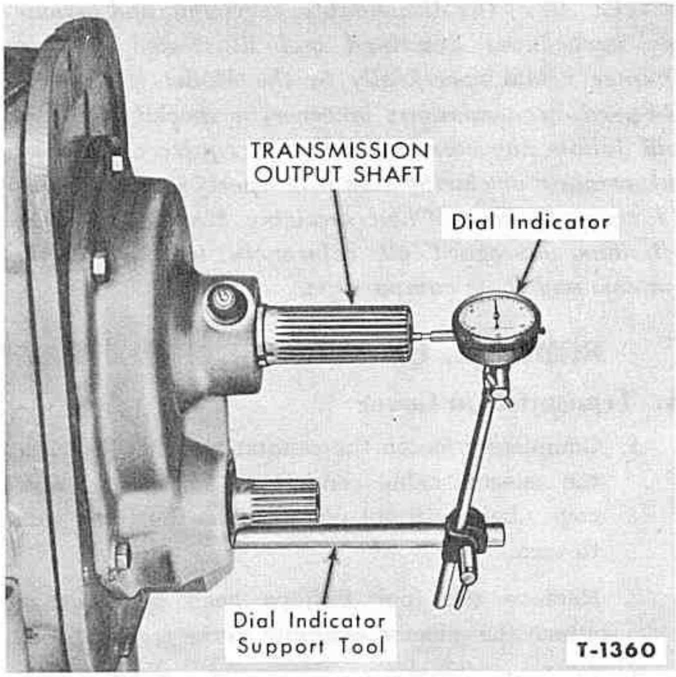


Figure 84—Checking Transmission Rear End Play

C. Transmission End Play Checks

Checking the Transmission Front End Play:

1. Pry the planetary "A" ring gear toward the rear of the transmission with a screw driver and check clearance between the "A" ring gear and "B" carrier, as shown in Figure 83.
2. Insert the screw driver between the "B" carrier and "A" ring gear and pry the ring gear toward the front of the transmission. Again check the clearance between these two units.
3. Record the difference between the two checks made with the gauge, shown in Figure 83 for reference during the transmission assembly. Front end play should be 0.005 to 0.015 inch.

Checking Transmission Rear End Play:

1. Back off the band 3 adjusting screw to completely release the band from the "C" carrier.
2. Mount the dial indicator support tool on the rear of the transmission case and install the dial indicator on the support so that the contact rests on the end of the transmission output shaft.
3. Push the output shaft toward the front of the transmission and set the dial indicator to zero, as shown in Figure 84, while maintaining a slight pressure on the shaft.
4. Pull the output shaft rearward and record the dial indicator reading for reference during trans-

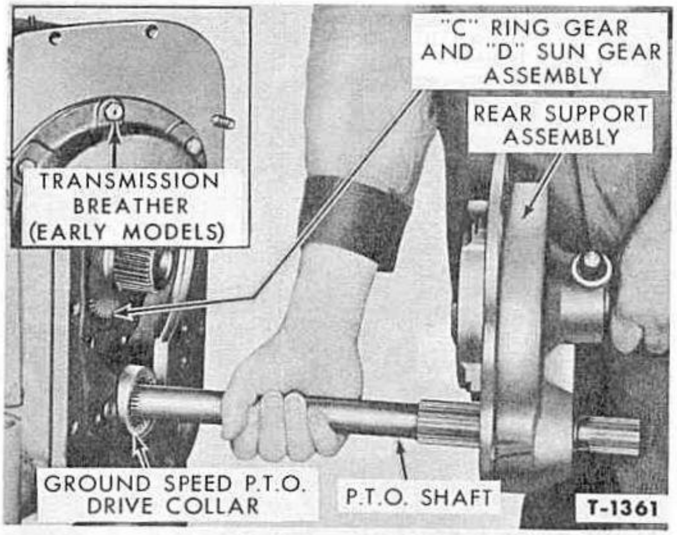

"C" RING GEAR AND "D" SUN GEAR ASSEMBLY
REAR SUPPORT ASSEMBLY
TRANSMISSION BREATHER (EARLY MODELS)
GROUND SPEED P.T.O. DRIVE COLLAR
P.T.O. SHAFT
T-1361

Figure 85—Removing the Rear Support

mission assembly. Rear end play should be 0.005 to 0.015 inch.

5. Remove the dial indicator and support tool from the rear of the transmission.

D. Transmission Case Components Removal—Tractor Split at Rear

1. Remove the five rear support attaching bolts, shown in the insert, Figure 85. On early units the top center bolt extends through the transmission case and is drilled to act as a breather. A nut and washer must be removed from the inside of the case before the bolt can be removed.

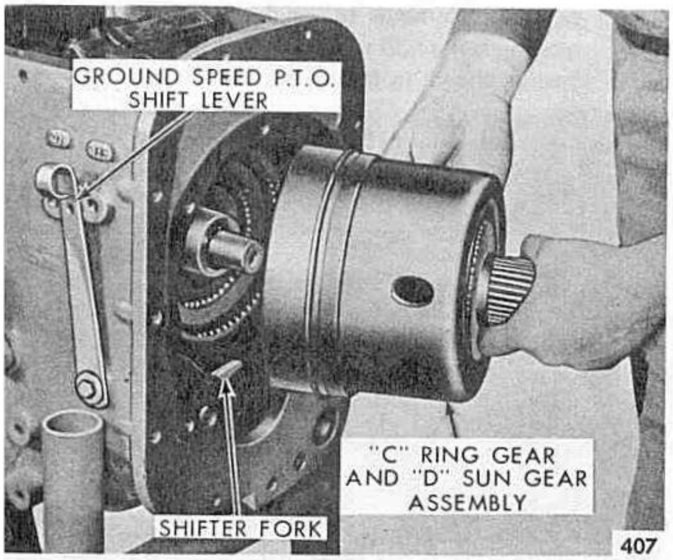

GROUND SPEED P.T.O. SHIFT LEVER
"C" RING GEAR AND "D" SUN GEAR ASSEMBLY
SHIFTER FORK
407

Figure 86—Removing the "C" Ring Gear and "D" Sun Gear

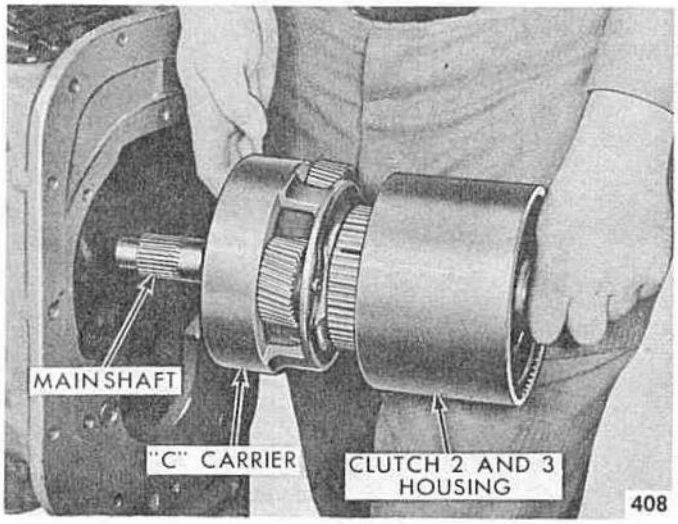


Figure 87—Removing the Mainshaft, "C" Carrier and Clutch 2 and 3 Housing

2. Remove the rear support assembly containing the "D" carrier and output shaft, and the ground speed P.T.O. gears and P.T.O. shaft on Model 81 transmissions.

   NOTE: *The single speed P.T.O. shaft on Model 71 transmissions must remain in place until it can be removed from the front of the transmission.*

3. Remove the ground speed P.T.O. drive collar, shown in Figure 85, from the shifter fork.

4. Move the ground speed P.T.O. shift lever as required to locate the drive collar shifter fork in its lower position, as shown in Figure 86. Remove the "C" ring gear "D" sun gear assembly as shown in Figure 86.

5. Loosen the No. 3 band adjusting screw and remove the clutch 2 and 3 housing, and "C" carrier and the mainshaft in one assembly, as shown in Figure 87.

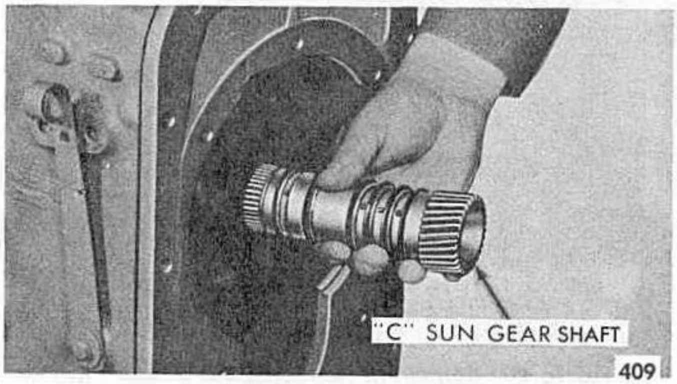


Figure 88—Removing the "C" Sun Gear Shaft

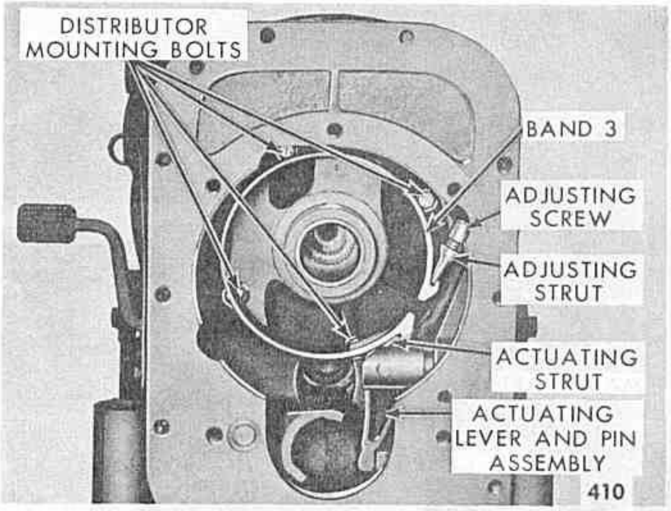


Figure 89—Band No. 3 in Position

6. Remove the "C" sun gear, as shown in Figure 88.
7. Manually compress No. 3 band while holding the adjusting strut and actuating strut, shown in Figure 89. Remove the band and two struts from the case.
8. Remove the nuts and flat washers from the servo 2 actuating lever pin and servo 3 actuating lever pin. Remove the servo lever pin retainer attaching bolt and the retainer. Remove the servo 3 lever and pin assembly, as shown in Figure 90. Remove the adjusting screw by threading it down through the case.

Model 71 Transmission: Remove the nuts and flat washers from the servo 2 and servo 3 actuating lever pins and remove servo lever pin retainer. Move servo pin 3 to the right until the shoulder of the pin contacts the transmission case. Swing servo 3 lever rearward just out of the servo piston rod. Remove the adjusting screw by threading it down through the case.

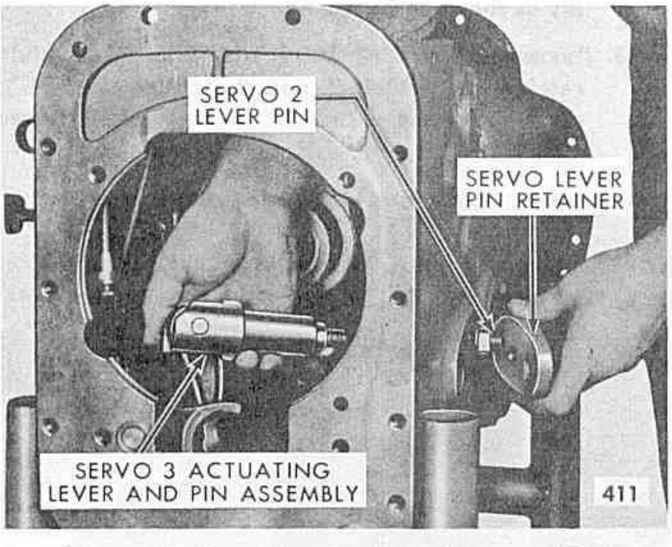


Figure 90—Removing the Servo Lever and Pin Assembly from Servo 3

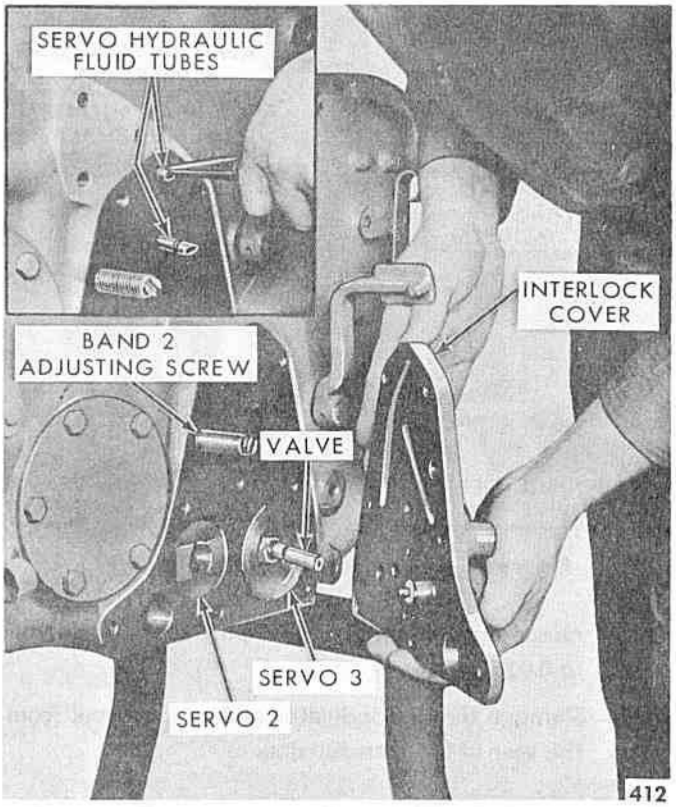


Figure 91—Removing the Servo Interlock Cover

9. Remove No. 2 band adjusting screw lock nut and washer and loosen the adjusting screw as much as possible. Remove the eight interlock cover attaching bolts and remove the interlock cover and gasket, shown in Figure 91.

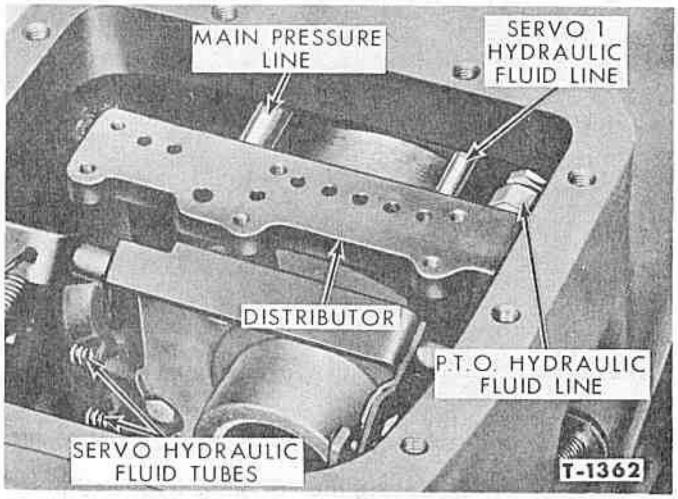

MAIN PRESSURE LINE
SERVO 1 HYDRAULIC FLUID LINE
DISTRIBUTOR
P.T.O. HYDRAULIC FLUID LINE
SERVO HYDRAULIC FLUID TUBES
T-1362

Figure 92—Fluid Distributor Mounted in Position

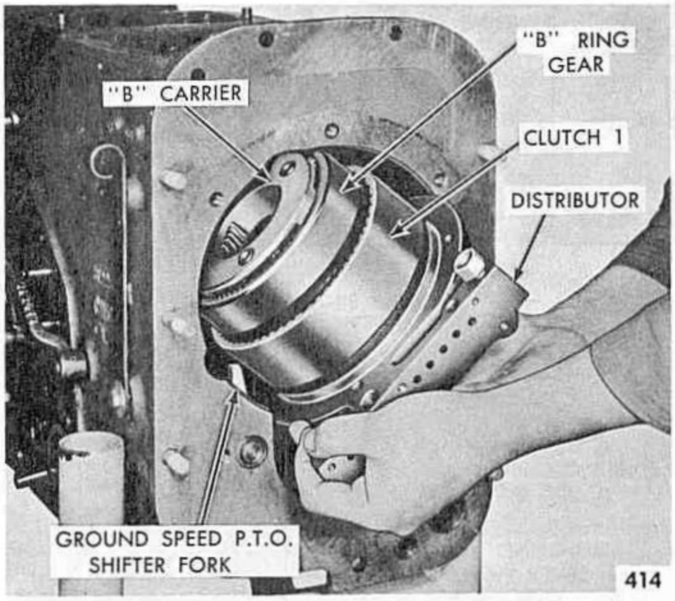


Figure 93—Removing the Distributor, Clutch 1, "B" Ring Gear and "B" Carrier

NOTE: ***No. 2 band must be completely free and the cover removed evenly to prevent damaging the valve attached to the servo 3 piston, shown in Figure 91.***

10. Loosen the four distributor attaching bolts, shown in Figure 89, and remove the two servo hydraulic fluid tubes from the distributor (but not from the transmission case) by twisting and pulling at the same time, as shown in the insert, Figure 91.
11. Disconnect the fitting that attaches the P.T.O. hydraulic fluid line to the distributor, as shown in Figure 92, and remove the four distributor attaching bolts.
12. Check to be sure that No. 2 band is loosened as much as possible. Move the ground speed P.T.O. shifter fork toward the rear, then pivot it up and out of the way, as shown in Figure 93.

Model 81 Transmission: Remove the distributor, clutch 1, "B" ring gear, and "B" carrier as an assembly, as shown in Figure 93.

Model 71 Transmission: Move the distributor slightly rearward and work the distributor out of clutch 1 housing leaving clutch 1 assembly in place. Raise the distributor up and over the servo 3 actuating lever and pin assembly allowing the lever to swing back into the servo piston rod. Remove the clutch 1 "B" ring gear, and "B" carrier.

13. Remove the "B" sun gear and "A" ring gear, shown in Figure 94. The "A" carrier and "A" sun gear assembly can now be removed from the transmission input shaft as shown in the insert, Figure 94.
14. Loosen the No. 1 band adjusting screw, compress the band while holding the actuating strut, shown in the insert, Figure 95, and remove the band and strut from the case.
15. Compress No. 2 band sufficiently to loosen and remove the adjusting strut and actuating strut. Now, No. 2 band can be removed by rotating it around the center web of the transmission as shown in Figure 95.
16. Remove the servo 2 actuating lever and pin assembly from the transmission case, Figure 90.
17. Remove the four servo 1 cover attaching bolts and remove the cover and servo from the right side of the transmission, as shown in Figure 96. Servo 3 and 2 are removed from the left side, as shown. Push the servo 2 bore and piston rod seal outward by hand.

E. Transmission Case Linkage

The transmission case linkage can be serviced with the tractor split at the rear of the transmission or with the transmission removed as follows:

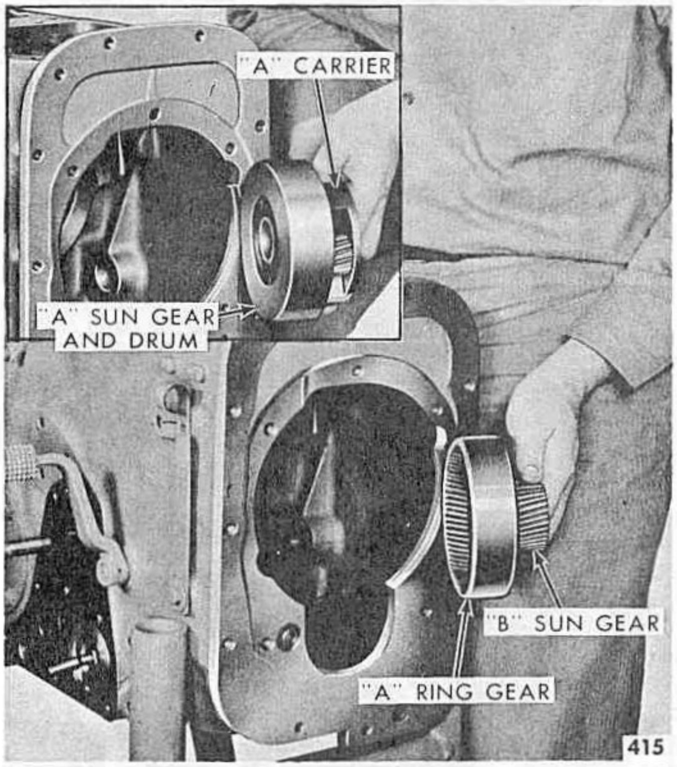


Figure 94—Removing the "B" Sun Gear and the "A" Planetary System

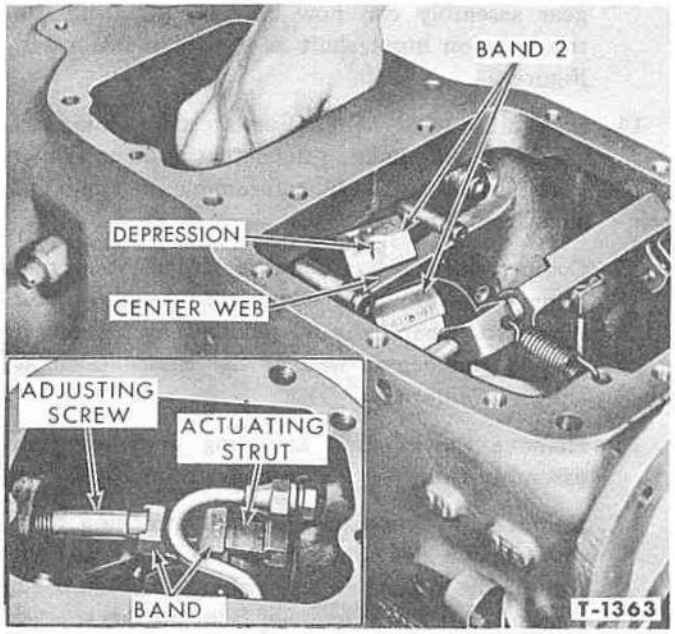


Figure 95—Removing Bands 1 and 2

1. Remove all rear components as required up to the distributor as previously outlined.
2. Remove the roll pin that secures the inching pedal, Figure 97, to the shaft. Remove the upper cotter pin and retainer clip then push the shaft into the case. Remove the lower cotter pin and retainer clip, then separate the rod from the shaft.
3. Remove the two snap rings from the feathering

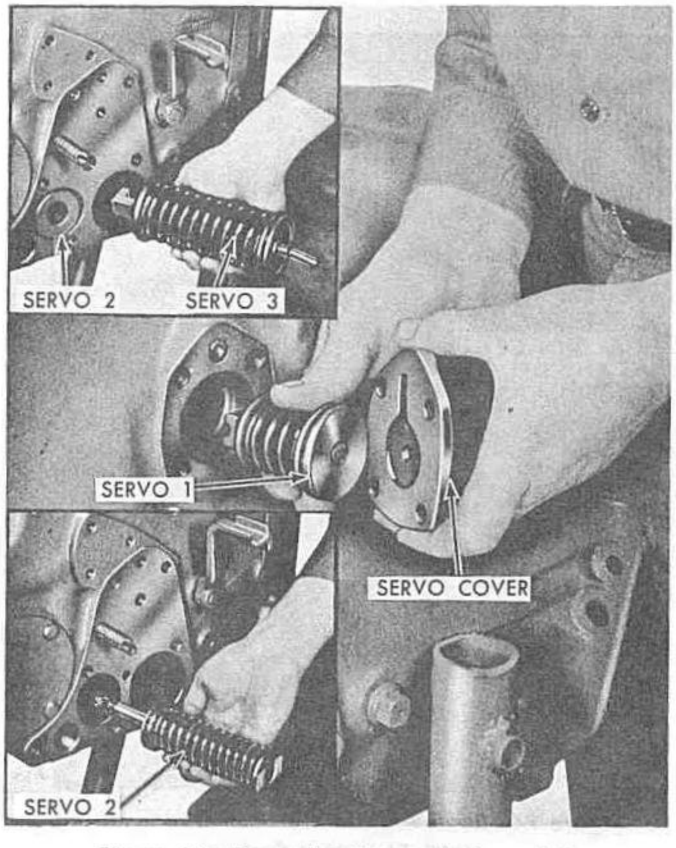


Figure 96—Removing Servos 1, 2, and 3

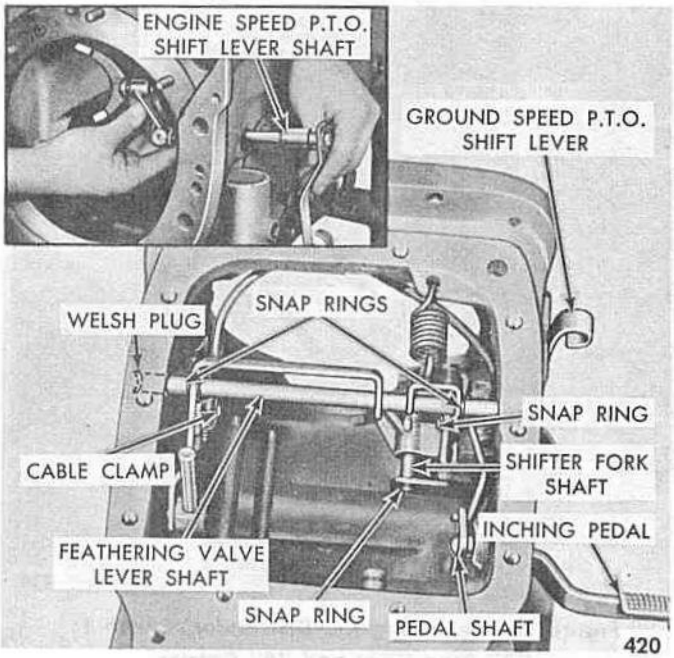

ENGINE SPEED P.T.O. SHIFT LEVER SHAFT
GROUND SPEED P.T.O. SHIFT LEVER
WELSH PLUG
SNAP RINGS
SNAP RING
CABLE CLAMP
SHIFTER FORK SHAFT
INCHING PEDAL
FEATHERING VALVE LEVER SHAFT
SNAP RING
PEDAL SHAFT
420

Figure 97—Removing the Transmission Case Linkage

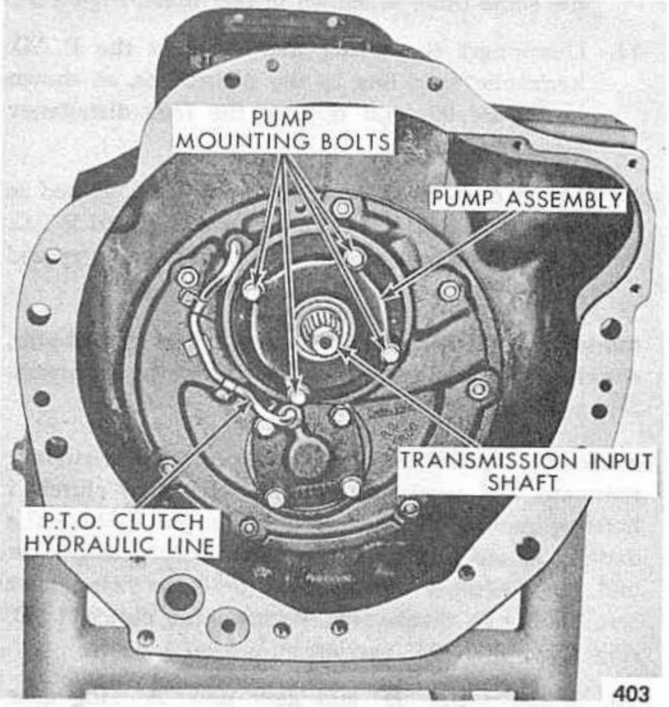


Figure 98—Removing the Pump Assembly

valve lever shaft, Figure 97. Drive the shaft to the right until the Welsh plug is out of the case. Then, remove the shaft.

Model 81 Transmission: It will be necessary to loosen the interlock cable clamp and the nut which supports the conduit, to remove the P.T.O. linkage.

Remove the snap rings from the lever shaft and from the fork shaft, shown in Figure 97, then remove the P.T.O. interlock mechanism, ground speed P.T.O. shift lever and the shifter fork. Remove the clevis pin and cotter pin from the shift lever shaft, then remove the engine speed P.T.O. shift lever.

F. Transmission Case Components Removal—Tractor Split at Front

1. Remove the four pump attaching bolts and remove the pump, Figure 98, from the transmission input shaft.

   NOTE: ***If the pump is stuck to the adapter plate, it can be loosened by tapping it with a soft-faced hammer.***

2. Remove the pump to adapter plate gasket.
3. On Models 71 and 81 transmissions, remove the P.T.O. clutch hydraulic fluid line, shown in Figure 98.
4. Move the P.T.O. shift lever to the 1000 rpm position.

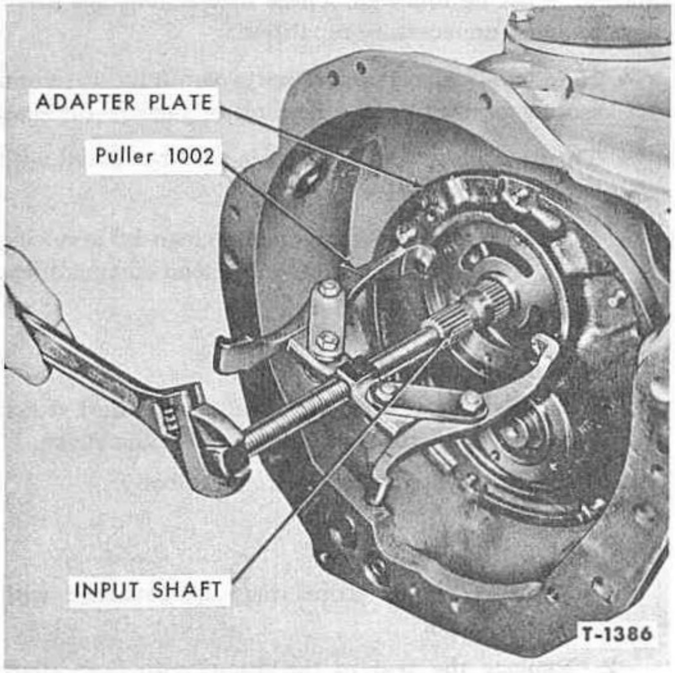


Figure 99—Pulling Adapter Plate

5. Remove the seven nuts that attach the adapter plate to the front of the transmission.
6. Install a suitable puller, as shown in Figure 99, against the input shaft using the pump mounting holes to pull on and remove the adapter plate.

   IMPORTANT: ***Do not remove the input shaft unless the transmission is out of the tractor as the "A" ring gear to carrier thrust washer can fall out of position.***

7. Remove the fluid lines from the transmission case if necessary. To remove the main supply line, push the tube forward and remove split-collar and "O" ring. Then move the tube forward and out of the case. The "O" ring on the P.T.O. tube must be installed from the front with the tube inserted through the opening.

G. Transmission Case Components Removal—Transmission Removed

The following operations can only be performed with the transmission removed from the tractor:

Input Shaft: Pull the input shaft forward to remove it as shown in the insert, Figure 100, and remove the two speed P.T.O. shifter fork from the lever assembly (Model 81 Transmission) shown in the insert, Figure 100.

Removing the P.T.O. System – Model 81 Transmission: Raise the P.T.O. clutch and shaft sufficient to permit removal of the complete assembly, as shown in Figure 101.

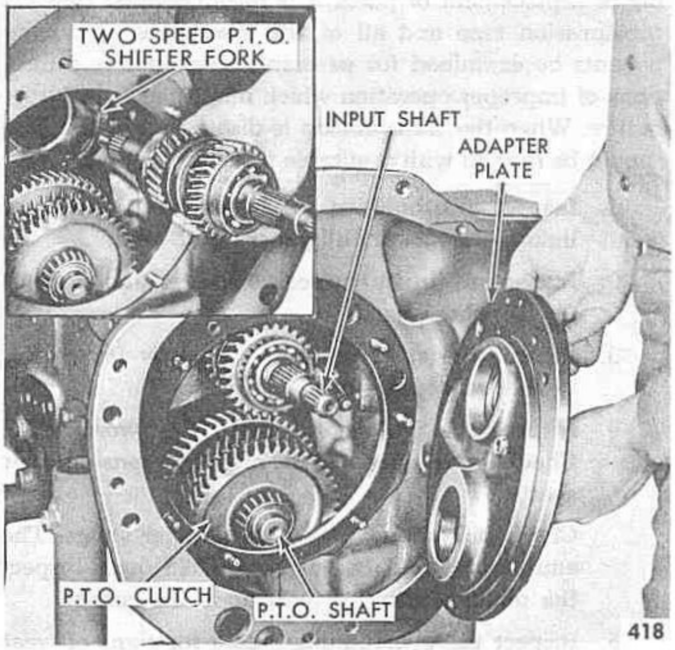


Figure 100—Removing the Adapter Plate and Input Shaft

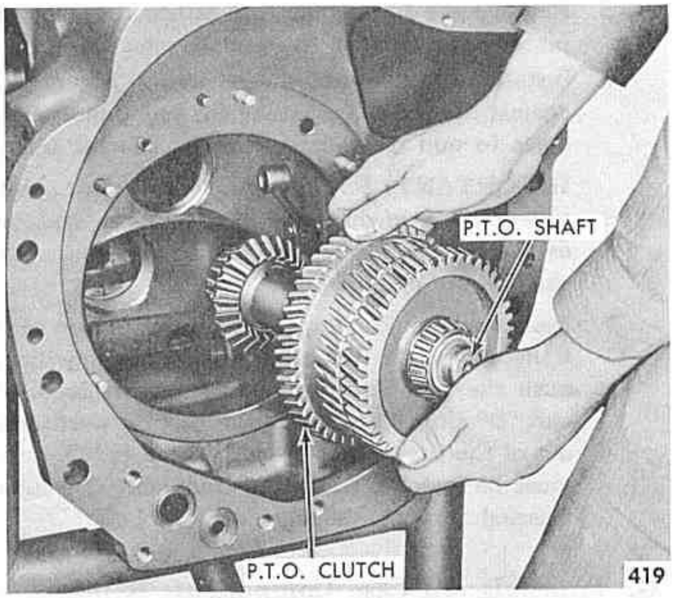


Figure 101—Removing the P.T.O. Clutch and Shaft—Model 81

Removing the P.T.O. System-Model 71 Transmission: Remove the snap ring and bearing from the rear of the P.T.O. Shaft and the snap ring directly behind the P.T.O. clutch pack. Raise the clutch assembly sufficiently to permit removal of the P.T.O. shaft from the front, then the clutch can be removed.

GENERAL INSPECTION

Whenever the transmission is disassembled for servicing or replacement of parts, it is recommended that the transmission case and all of the assemblies, and components be examined for excessive wear or any indications of improper operation which might result in future failure. When the transmission is disassembled, the case should be flushed with a suitable solvent.

1. Inspect transmission case for cracks and the linkage for proper alignment and wear.
2. Inspect all thrust surfaces, bushings, and journals for scores or wear.
3. Inspect the shaft seals and grooves for cracks, breaks, scores and burrs.
4. Inspect the pinions for broken or worn teeth. Check for free movement of the pinions on their shafts.

   Check pinion end play with a feeler gauge. The end play should be 0.008 to 0.025 inch. Inspect the pinion shafts for tight fit in the carrier.
5. Inspect the overrunning clutch for signs of wear and roughness. Inspect the sprag ends for flat spots.
6. Inspect the clutch pistons and servo bores for scores, roughness and wear.
7. Inspect the bands for damage or excessive wear.
8. Inspect the pump assembly for scores, cracks and wear.
9. Inspect all splines for scores, burrs and wear.
10. Inspect the control valve assembly for proper operation of the plunger and spool type valves. Check the cam shaft assembly for wear, cracks and damage.
11. Make certain all fluid passages, lines and tubes are not obstructed.
12. Check the mating surfaces of the distributor and control valve for scores, burrs and flatness.

REPAIR AND ASSEMBLY OF SUB-ASSEMBLIES

The repair procedures given in this section include the disassembly, inspection, and assembly of the sub-assemblies removed from the transmission case. The proper installation of the various thrust washers used in the transmission is one of the most important steps in transmission build-up. The construction of each thrust washer and its position is shown in Figure 102. Refer to this illustration during transmission assembly to avoid mistakes.

During the repair of the sub-assemblies, certain general instructions, which apply to all units of the transmission, must be followed. These instructions are given here to avoid unnecessary repetition:

- Handle all transmission parts carefully to avoid scoring or burring the bearing or mating surfaces.
- Thrust washers and shaft seals may be coated with vaseline to facilitate assembly.
- Keep all parts and components clean by servicing these items with clean tools in clean surroundings, using lint-free wipers.

A. Pump Disassembly

1. Remove the two Phillips head screws that attach the cover to the body and remove the cover.
2. Lift the rotor and rollers from the body.

B. Inspection and Repair

1. Minor burrs or scores may be removed with crocus cloth.
2. Replace the seal in the pump with Step Plate 630-5, as shown in Figure 103.

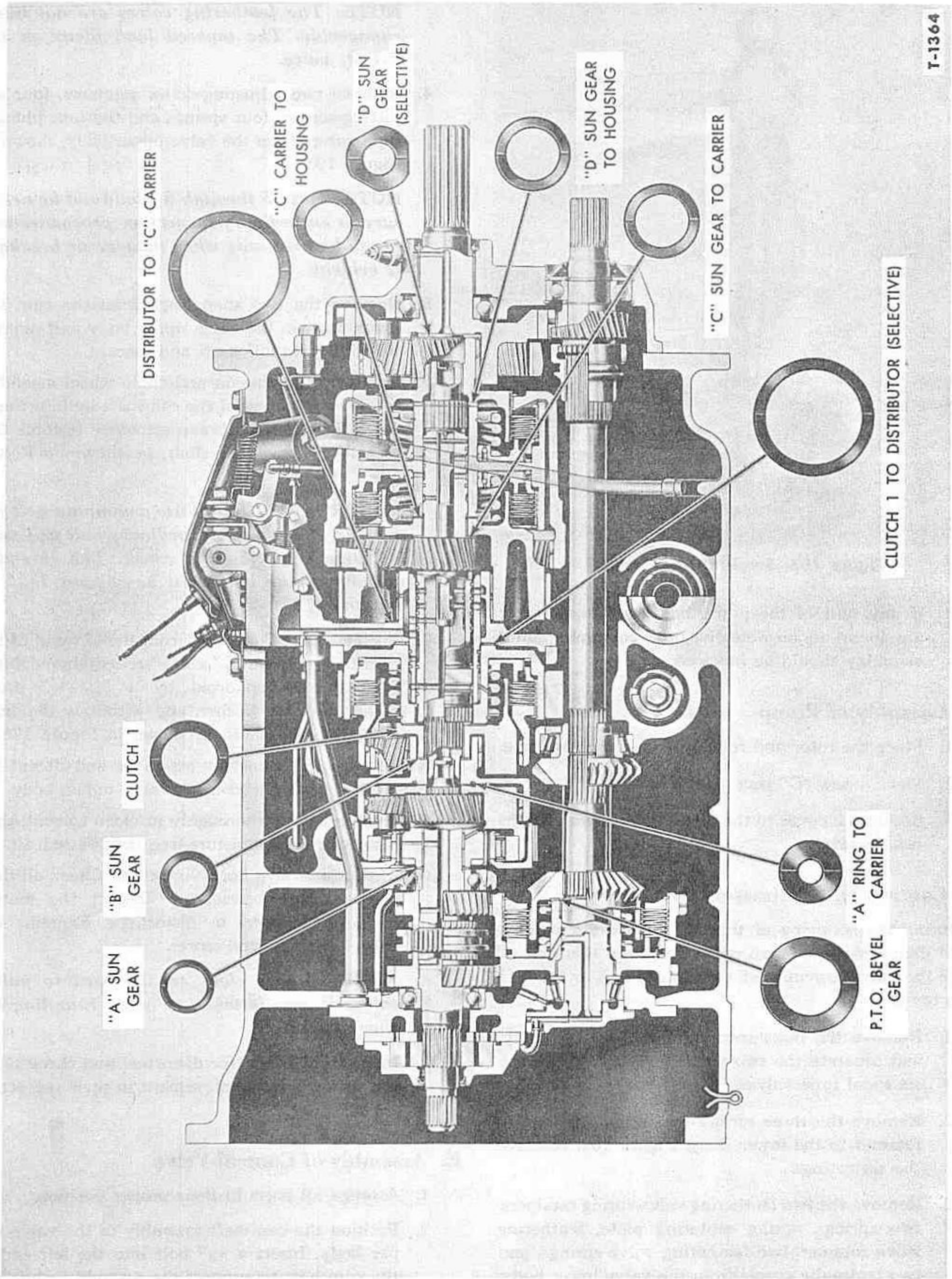


Figure 102—Thrust Washer Location

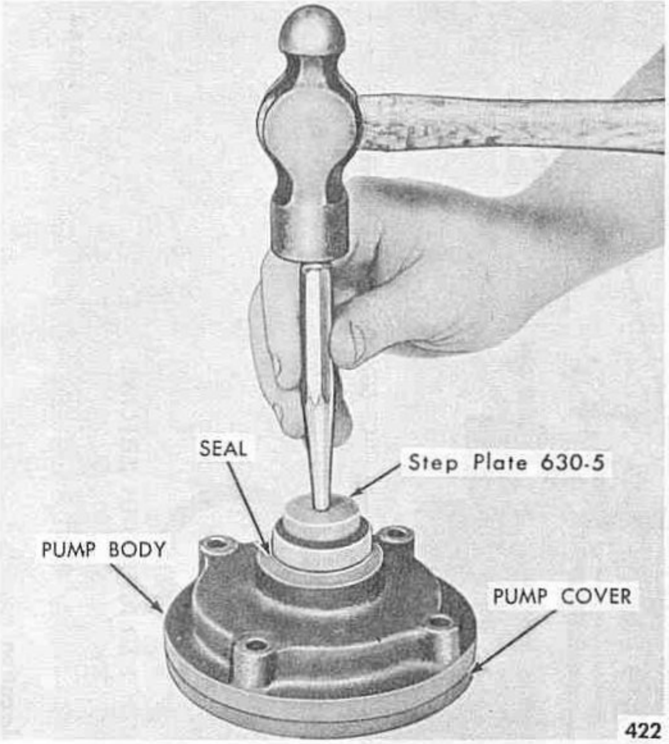


Figure 103—Servicing the Pump

3. If any part of the pump body, rollers, or rotor are found to be defective, the complete pump assembly should be replaced.

C. Assembly of Pump

1. Place the rotor and rollers in the pump housing.
2. Place a new "O" ring on the housing.
3. Secure the cover to the housing with two Phillips head screws.

D. Control Valve Disassembly

During the servicing of the control valve assembly, avoid damage to the valve parts, and keep them clean. Place the valve assembly on a clean chamois or lint-free shop towel.

1. Remove the bolts securing the valve assembly, and separate the two valve bodies. Remove the six spool type valves.
2. Remove the three screws that attach the spring retainer to the lower body, Figure 104. Remove the six springs.
3. Remove the two feathering valve spring retainers, two springs, spring centering plate, feathering valve retainer, two feathering valve springs, and two hydraulic spools from the valve lower body.

   NOTE: ***The feathering valves are not interchangeable. The tapered land identifies the P.T.O. valve.***

4. Remove two adjusting screw retainers, four adjusting screws, four springs and the four plunger type valves from the valve upper body, shown in Figure 105.

   NOTE: ***Steps 5 through 8 would not be necessary in an ordinary inspection procedure and are to be used only when damage or breakage is evident.***

5. Remove the two snap rings from the cam follower shaft in the valve upper body and remove the shaft, cam followers, and spacers.
6. Remove the trunnion and cable wheel assembly from the right end of the camshaft by inserting a ¼" x 2" standard thread set screw to force this assembly out of the shaft, as shown in Figure 106.

   IMPORTANT: ***Do not use a common bolt for pulling this wheel. An ordinary bolt will twist off before pulling the wheel. The threaded portion of the bolt must be at least 1¾" in length.***

7. To remove the trunnion from the left end of the camshaft, insert a ¼" x 1⅛" coarse thread, heat-treated bolt supported by a 7/16"-⅜" drive, socket and flat washer, and withdraw the trunnion from the shaft, as shown in Figure 106.
8. Remove the camshaft assembly and detent assembly from the control valve upper body.
9. Clean all parts thoroughly in clean solvent, then blow dry with moisture-free compressed air.
10. Inspect all valve bores for scores. Check all fluid passages for obstructions. Inspect the mating surfaces for burrs or distortions. Examine the valves for burrs and scores.

    NOTE: ***Crocus cloth can be used to polish valves if care is taken to avoid rounding the sharp edges.***

11. Inspect all springs for distortion and check all of the valves for free movement in their respective bores.

E. Assembly of Control Valve

1. Arrange all parts in their proper position.
2. Position the camshaft assembly in the valve upper body. Insert a ⅜" bolt into the left end of the camshaft to support the assembly while the

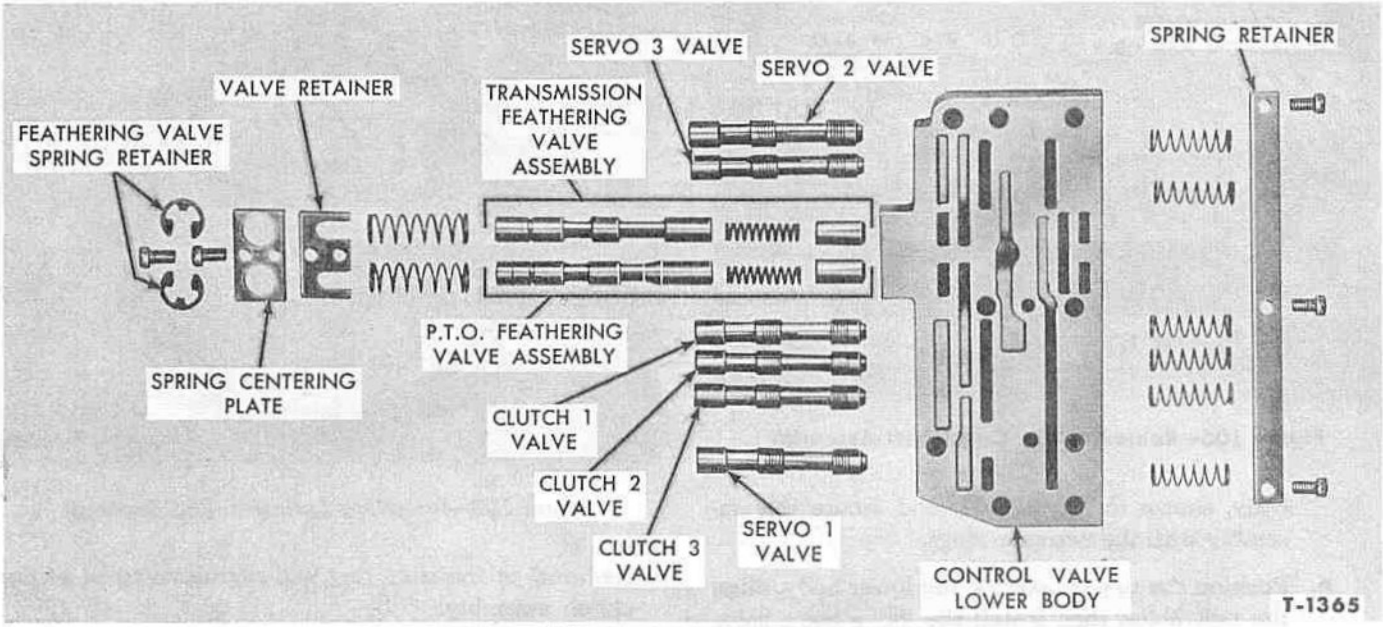


Figure 104—Control Valve Lower Body

cable wheel and trunnion assembly is being pressed into the right end, as shown in Figure 107. A clearance of 0.015 inch should be maintained between the cable wheel and valve body, as shown. Press the trunnion into the left end of the camshaft as shown in the insert, Figure 107.

3. Install the valve springs, retainers and all of the valves in the control valve upper and lower bodies. Rotate the spool valves when inserting them in their bores to avoid shaving the body casting.
4. Install the plunger valve springs and adjusting screws in the control valve upper body.

   NOTE: ***Turn the four valve adjusting screws into the valve body until they are flush with the front side. These valves must be adjusted under operating conditions with the transmission installed in the tractor. Then, the control valve assembly will have to be removed to permit locking these valves with the two retainers.***
5. Install the cam followers, spacers and shaft in their respective positions on the valve upper

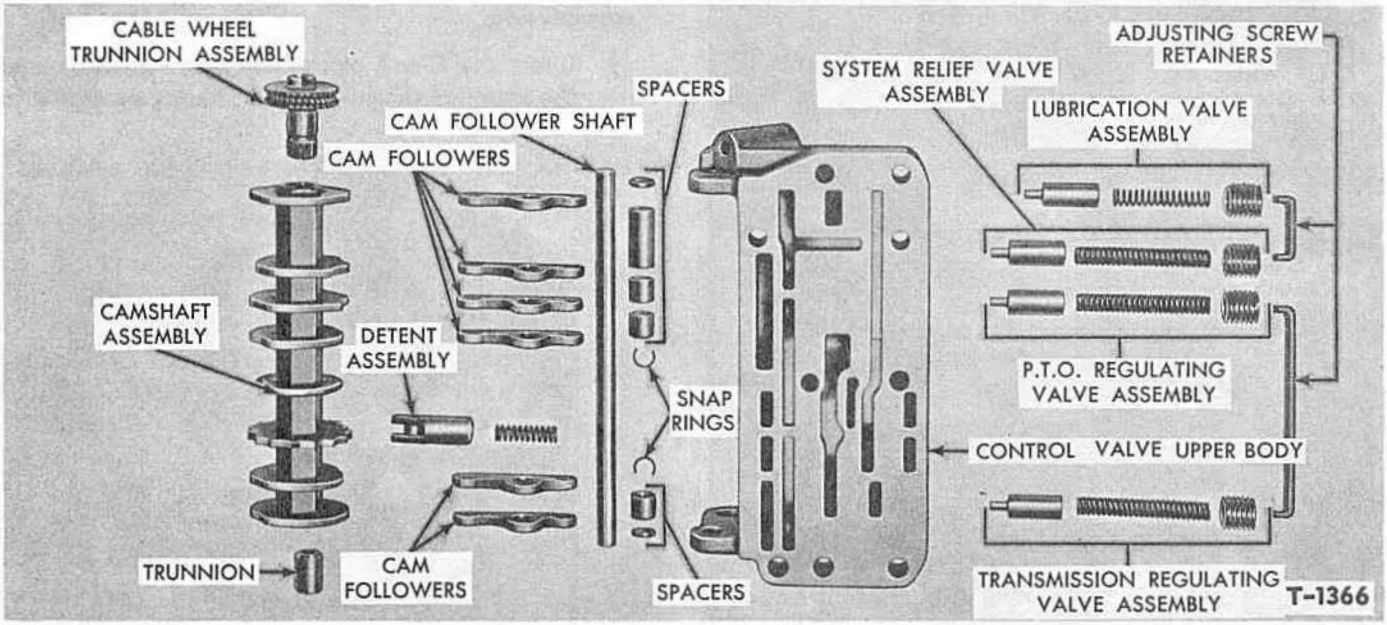

CABLE WHEEL TRUNNION ASSEMBLY
SPACERS
CAM FOLLOWER SHAFT
CAM FOLLOWERS
SYSTEM RELIEF VALVE ASSEMBLY
ADJUSTING SCREW RETAINERS
LUBRICATION VALVE ASSEMBLY
CAMSHAFT ASSEMBLY
DETENT ASSEMBLY
SNAP RINGS
P.T.O. REGULATING VALVE ASSEMBLY
CONTROL VALVE UPPER BODY
TRUNNION
CAM FOLLOWERS
SPACERS
TRANSMISSION REGULATING VALVE ASSEMBLY
T-1366

Figure 105—Control Valve Upper Body

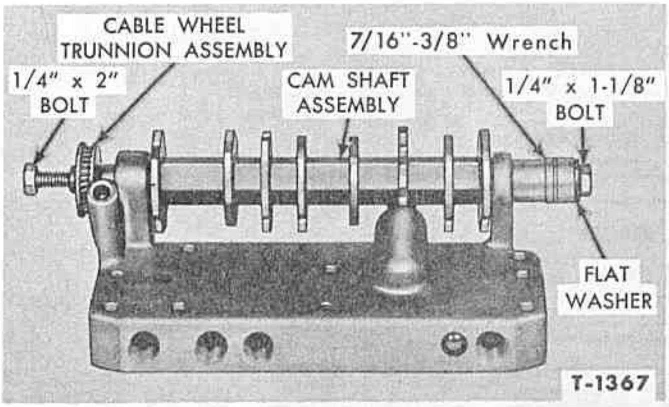


Figure 106—Removing the Cam Shaft Assembly

body, shown in Figure 105, and secure this assembly with the two snap rings.

6. Position the upper body on the lower body, align the bolt holes, then install the valve body bolts, and align both bodies as outlined on page 223. before tightening bolts equally to 6-8 ft. lbs. torque.

   IMPORTANT: ***Excessive tightening of these bolts may distort the valve bodies, causing the valves to stick.***

F. Disassembly of Overrunning Clutch

The overrunning clutch is secured to the "A" sun gear and drum assembly, as shown in Figure 113.

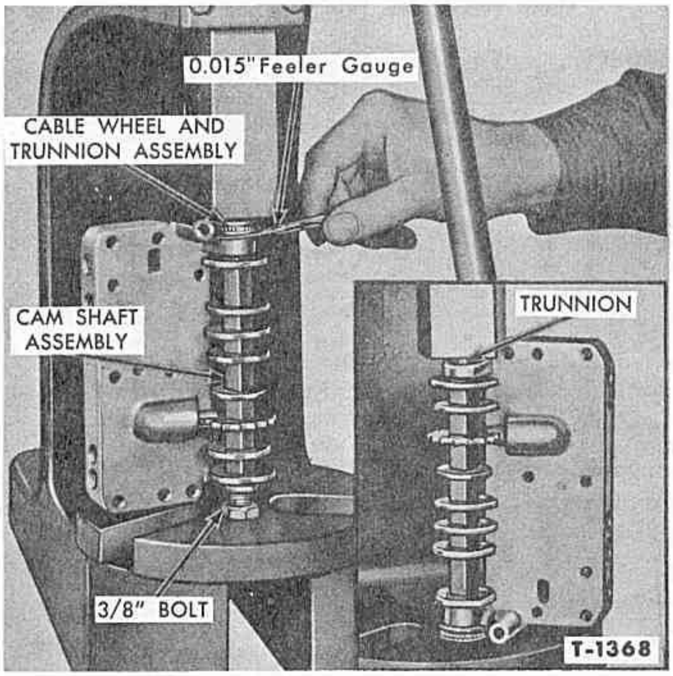


Figure 107—Installing the Cam Shaft Assembly

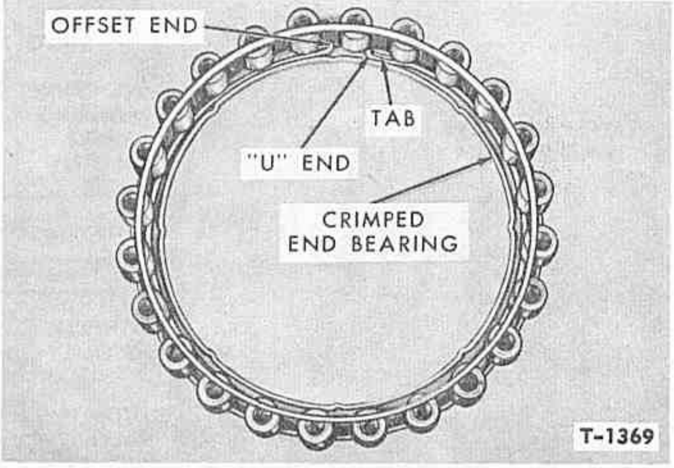


Figure 108—Installing Spring in End Bearing

Removal of the snap ring will permit removal of the clutch assembly.

Inspect the overrunning clutch for wear or roughness, flat rollers, broken springs, damaged or worn end bearings and cages. If any of these conditions exist, the overrunning clutch should be replaced.

G. Assembly of Overrunning Clutch

Early Model Select-O-Speed Transmissions were equipped with a sprag type one-way clutch. When replacement of the sprag type clutch is required, the new roller type overrunning clutch must be used. The following procedure should be carefully followed when building up an overrunning clutch and used to check the assembled clutch prior to installation in the transmission.

1. Insert the U-end of the end bearing spring into the crimped tab in the end bearing as shown in

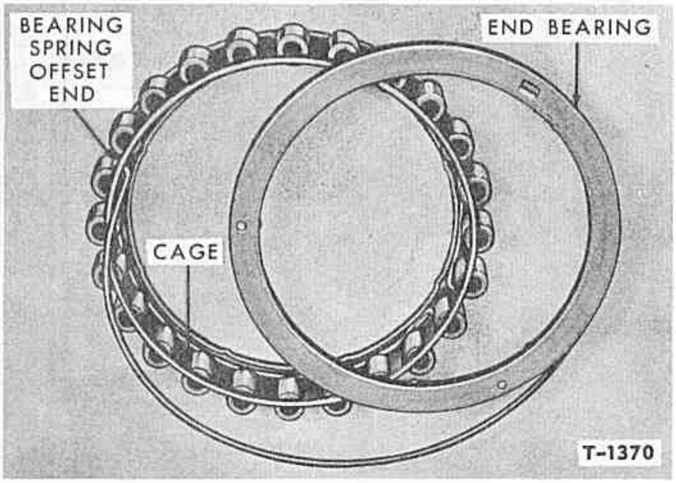


Figure 109—Installing Spring in End Bearing

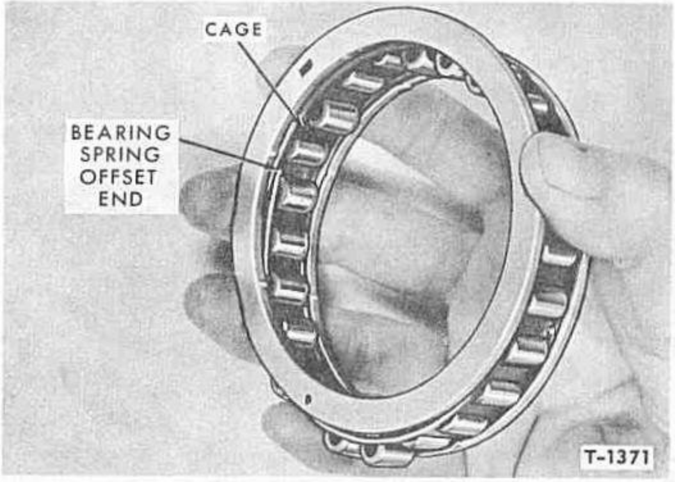


Figure 110—Installing Spring in End Bearing

Figure 108, and the offset end into the hole in the cage. The offset end must be installed in toward the cage to permit the spring to be properly located with respect to the rollers.

2. Rotate the bearing with respect to the cage so the spring is wound within the inside diameter of the cage. See Figures 109 and 110.
3. In those assemblies using a drum spacer, check to make sure the drum spacer is installed squarely against the drum. See Figure 111. The spacer properly positions the clutch with respect to the retaining snap ring groove for proper end clearance.
4. Position the overrunning clutch, noting that either the arrow head or crimped end bearing is positioned up, over the sun gear race, Figure 111. The crimped bosses on the I.D. of the end bearings are to be aligned in adjacent valleys. *Do not attempt to align the upper and lower end bearing bosses in the same valleys as malfunctioning will result.*

   NOTE: ***When installing the clutch, it is necessary to hold the loose or lower end bearing tight to the cage to prevent the spring from becoming unwound. This can be accomplished with the ends of the fingers, as shown in Figure 112.***
5. With the clutch properly positioned on the sun gear race, install the retaining snap ring in the groove as follows:
   a. Thread one end of the ring into the groove, holding the offset and opposite end of the ring out of the groove with 0.015-inch feeler stock. See A, Figure 113.
   b. Lock the upper free end of the ring to the center portion of the ring by lining up and inserting the stamped projection into the elongated slot. See B, Figure 113.
   c. With the drum firmly held, remove the feeler stock and snap the rest of the ring into the groove using a screwdriver, as shown at C, Figure 113.

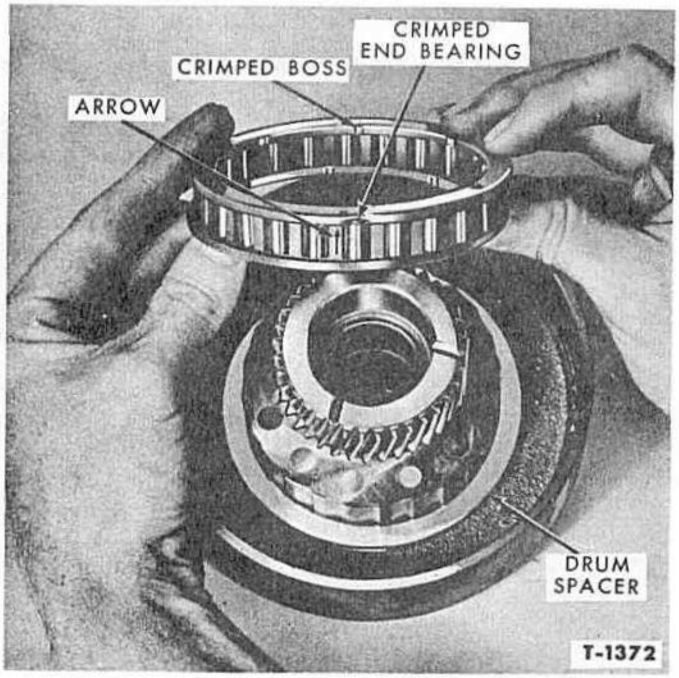


Figure 111—Positioning the Overrunning Clutch

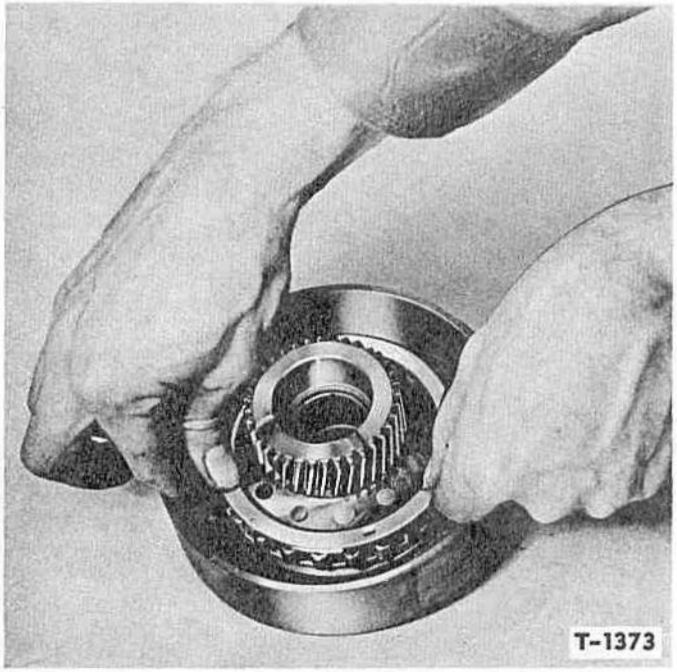


Figure 112—Positioning the Overrunning Clutch

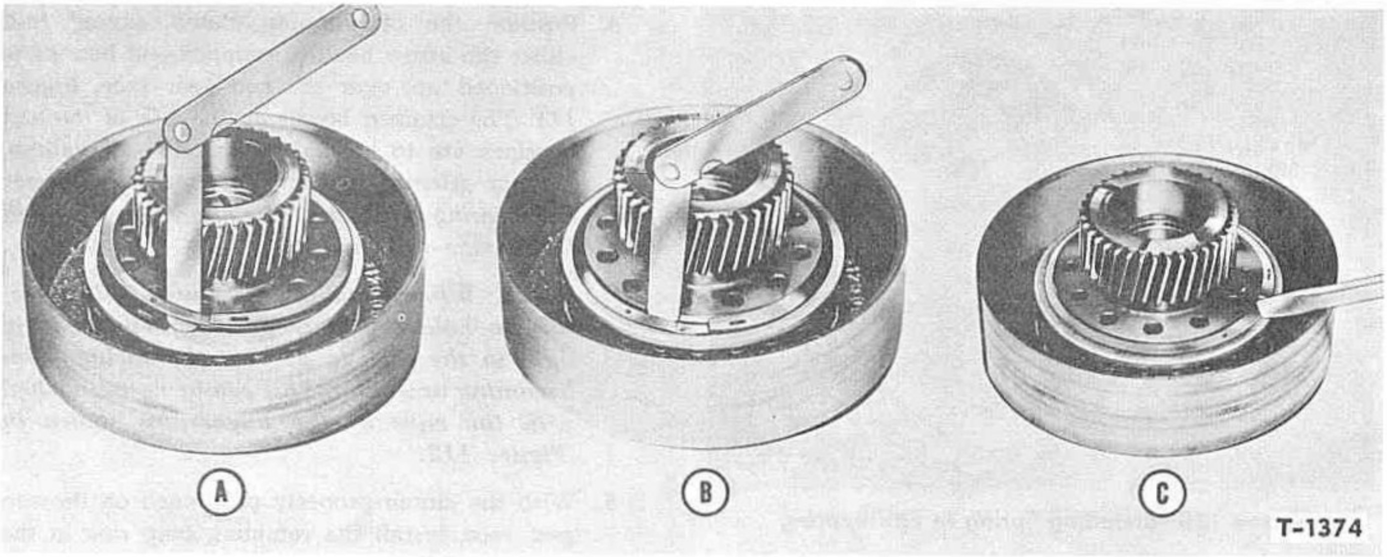


Figure 113—Installing Overrunning Clutch Retaining Snap Ring

6. Install the "A" carrier over the clutch by rotating it counterclockwise to cause the rollers to go into the correct valleys. *Opposite, or clockwise, rotation of the carriage may tend to force the rollers in the adjacent valleys and result in damage to the clutch.* A final check to insure that the carrier has been properly assembled is to rotate the carrier, while holding the sun gear on a bench. Clockwise rotation of the carrier will cause the clutch to lock up. Counterclockwise rotation will cause freewheeling.

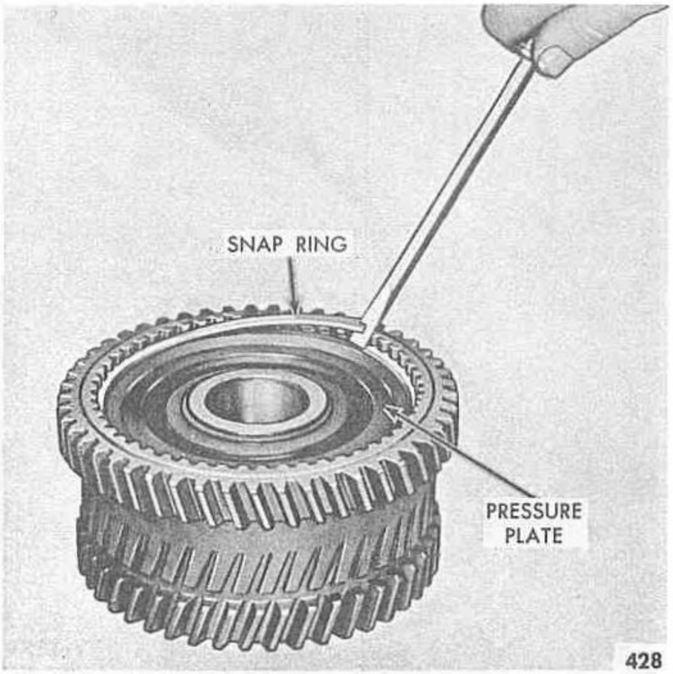


Figure 114—Clutch Snap Ring Removal

H. Disassembly of Clutch Packs

The following procedure pertains to all clutch packs in the Select-O-Speed Transmission. For purpose of illustration, the P.T.O. clutch assembly (Model 81 transmission) will be shown in Figures 114 through 118.

When servicing clutch assembly 2 and 3, it will be necessary to remove the snap ring at the rear of the mainshaft and remove the mainshaft from the clutch assemblies.

1. Remove the clutch pressure plate snap ring as shown in Figure 114.

NOTE: *In clutch 1, the "B" ring gear is*

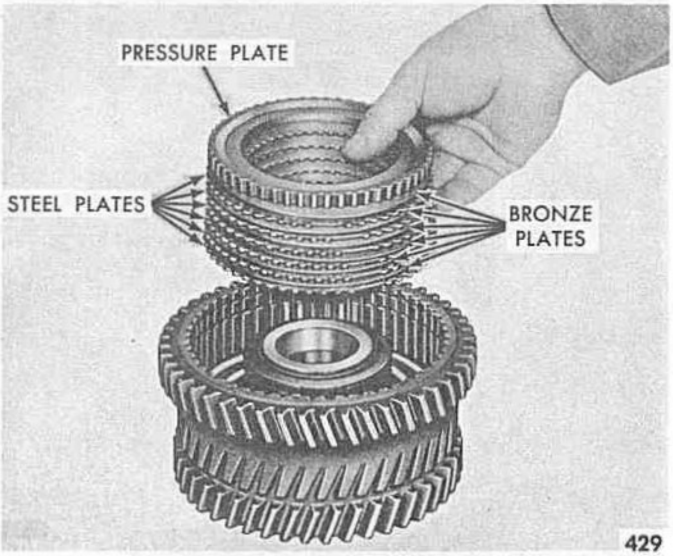


Figure 115—Removing the Clutch Plates

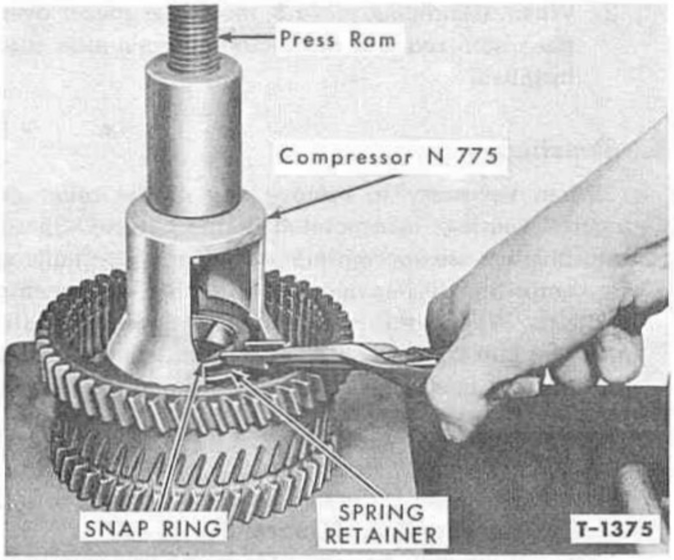


Figure 116—Clutch Spring Snap Ring Removal

splined to the clutch housing, secured with a snap ring and functions as a pressure plate.

2. Remove the pressure plate and bronze and steel plates from the clutch housing, shown in Figure 115.
3. Compress the piston return spring in a press with the Compressor N 775 shown in Figure 116, then remove the snap ring. Guide the spring retainer while releasing the press to prevent the retainer from entering the snap ring groove.

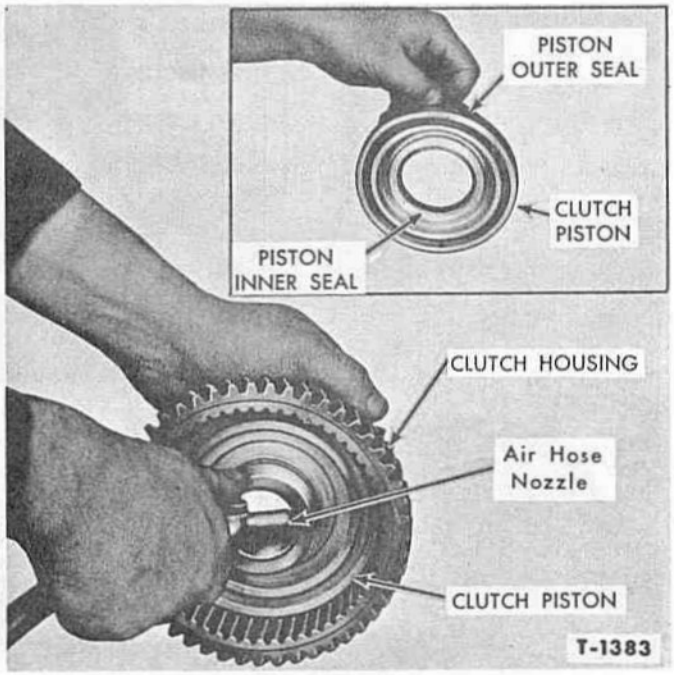


Figure 117—Clutch Piston Removal

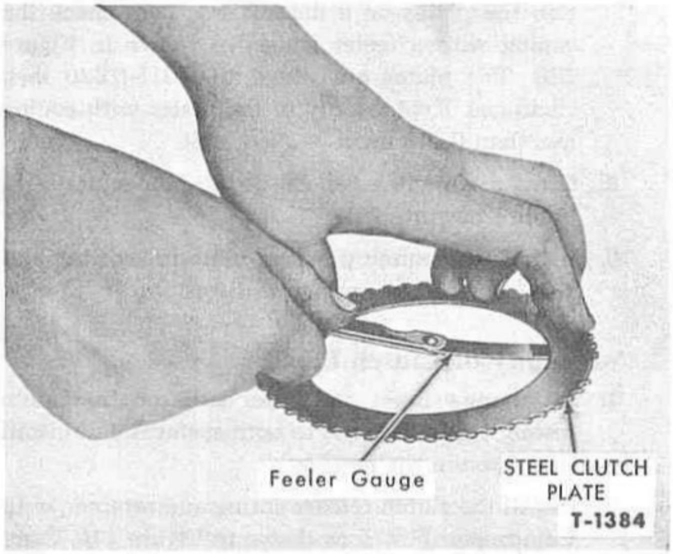


Figure 118—Checking Steel Clutch Plate Coning

4. Place an air hose nozzle in the hole in the hub, as shown in Figure 117, and force the piston out of the clutch housing with air pressure.
5. Remove the piston inner and outer seals, shown in the insert, Figure 117.
6. Inspect the clutch piston and bore for scoring and check the fluid passages for obstructions.
7. Inspect the clutch plates for distortion, wear and scores. Check the coning of the steel plates. Posi-

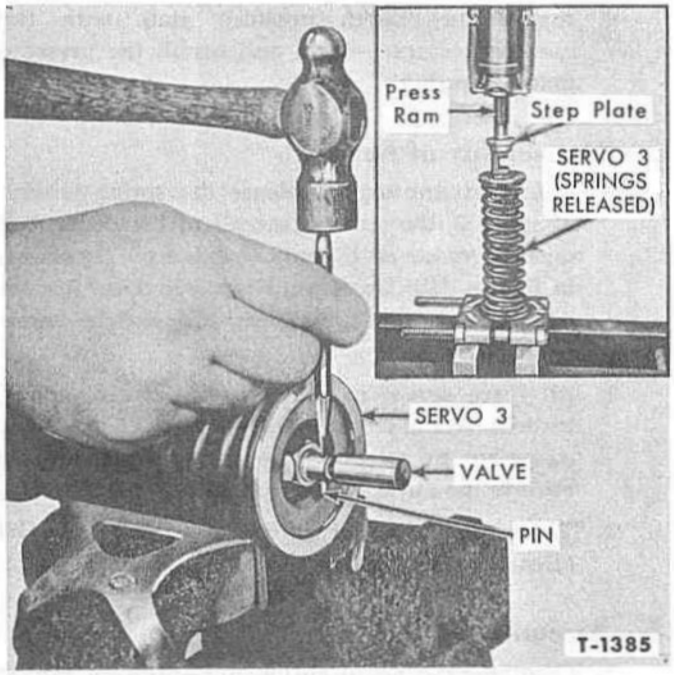


Figure 119—Servicing the Servos

tion the plates on a flat surface, then check the coning with a feeler gauge, as shown in Figure 118. The plates are coned to 0.015-0.020 inch clearance. Replace any of the plates with coning less than 0.015 inch.

8. Using a straight edge, check the bronze plates to be sure they are flat.
9. Inspect the clutch pressure plate for scoring and check the release spring for distortion.

I. Assembly of Clutch Packs

1. Install new inner and outer seals on the clutch piston, apply vaseline to both surfaces and install the piston in the housing.
2. Install the clutch release spring and retainer, with Compressor N 775 as shown in Figure 116. Compress the spring in a press and install the snap ring.

   CAUTION: ***Make sure the snap ring is fully seated in the groove.***

3. Install the steel and bronze clutch plates alternately, starting with a steel plate next to the piston. Because of coning, all steel plates must face the same direction, all concave (hollow) sides up.

   NOTE: ***The model 81 transmission P.T.O. clutch pack contains six steel and six bronze plates. All other clutch packs contain five steel and five bronze plates.***

4. Install the clutch pressure plate with the machined surface down and install the pressure plate snap ring.

J. Disassembly of Servos

1. Before attempting to release the spring tension of servo 3, the valve attached to the piston rod must be removed by removing the pin, as shown in Figure 119. Use a punch smaller than the pin diameter so that the holes will not be made oversized.
2. All three servos in the transmission are spring loaded. When servicing servos 2 or 3 it will be necessary to compress the spring sufficiently to remove the nut on the piston rod.
3. Then, the spring or springs (servo 3) can be released, as shown in the insert, Figure 119.

K. Assembly of Servos

1. Compress the servo spring and install the nut on the piston rod.
2. When assembling servo 3, insert the spacer over the piston rod and stake the valve pin after it is installed.

L. Bearings

When necessary to remove any of the roller or tapered bearings incorporated in the Select-O-Speed transmission, use appropriate bearing and gear pullers. Be careful not to damage any adjoining components or shafts. When pressing bearings on the input shaft, make certain they are fully seated and that the slot on the front maximum capacity bearing is positioned forward.

The P.T.O. shaft center bearing race (Model 81 transmission) can be easily removed using Bearing Race Puller and Slide Hammer No. 943.

The output shaft bearing (Model 81 transmission) can be removed by alternately wedging each side of the bearing using a cold chisel or pry bars.

M. Flow Restrictor Valves

1. The servo 3 return flow restrictor valve must be pressed into the interlock cover with the opening in a vertical position, as shown in Figure 120. Otherwise, the fluid passage to servo 3 would not deliver fluid properly, and could be completely closed off.
2. The servo 1 flow restrictor valve, shown in the insert, Figure 120, was used on early production

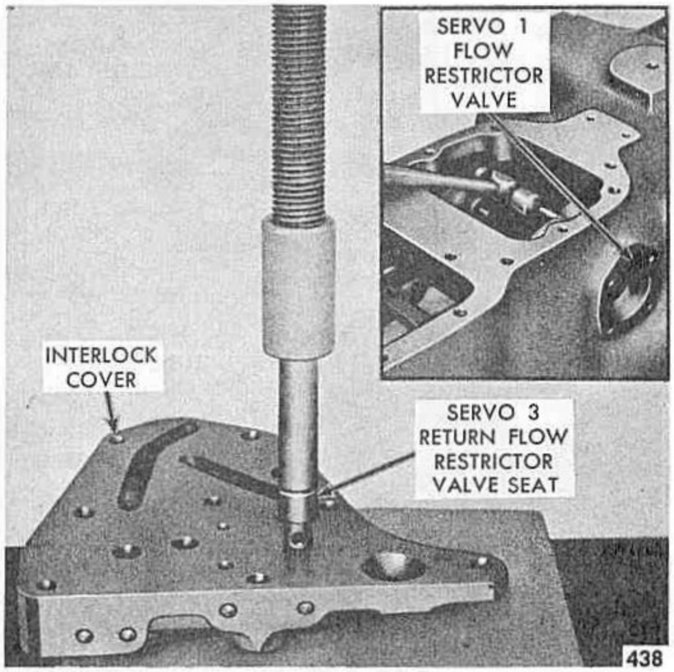

SERVO 1 FLOW RESTRICTOR VALVE
INTERLOCK COVER
SERVO 3 RETURN FLOW RESTRICTOR VALVE SEAT
438

Figure 120—Servicing Flow Restrictor Valves

Select-O-Speed transmissions. This valve has been removed in production and should be removed from all transmissions when they are disassembled for any reason. It was found on some units that the steel ball check valve peens the valve seat, restricting the oil flow to the servo. To remove the valve seat proceed as follows:

a. Loosen band 1 adjusting screw lock nut.

b. Loosen the four bolts securing the No. 1 servo cover, at the same time threading in the adjusting screw to compensate for outward piston movement.

NOTE: ***Do not force the piston outward. Care should be exercised to keep the piston in the bore, otherwise the band strut may drop out of place.***

c. Insert a suitable tool which incorporates an offset, and pull out the valve seat as shown in Figure 121. This will permit the check ball, spring, and washer to be removed.

d. Replace the gasket and install the cover in reverse of the procedure covered in step b.

e. Adjust band 1.

N. Disassembly of Speed Selector

1. Remove the two side covers and three Phillips head screws to separate the selector assembly, as shown in Figure 122.
2. Remove the hex nut from the shaft and remove the snap ring and retainer plate to expose the wheel and cable assembly, shown in Figure 123. The shaft can now be withdrawn and the wheel and cable can be removed.

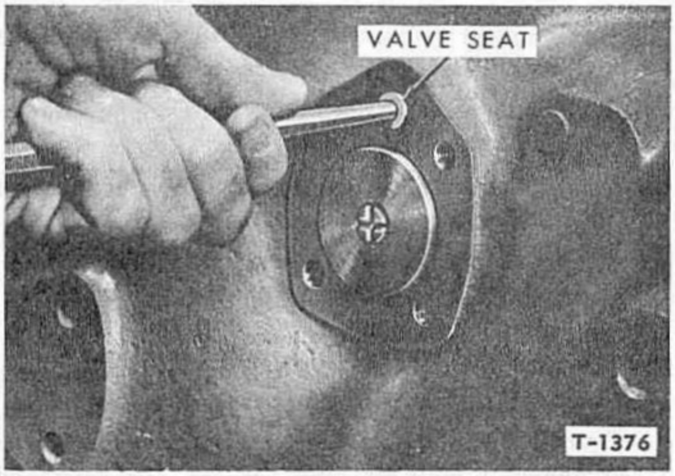


Figure 121—Removing Servo 1 Flow Restrictor Valve

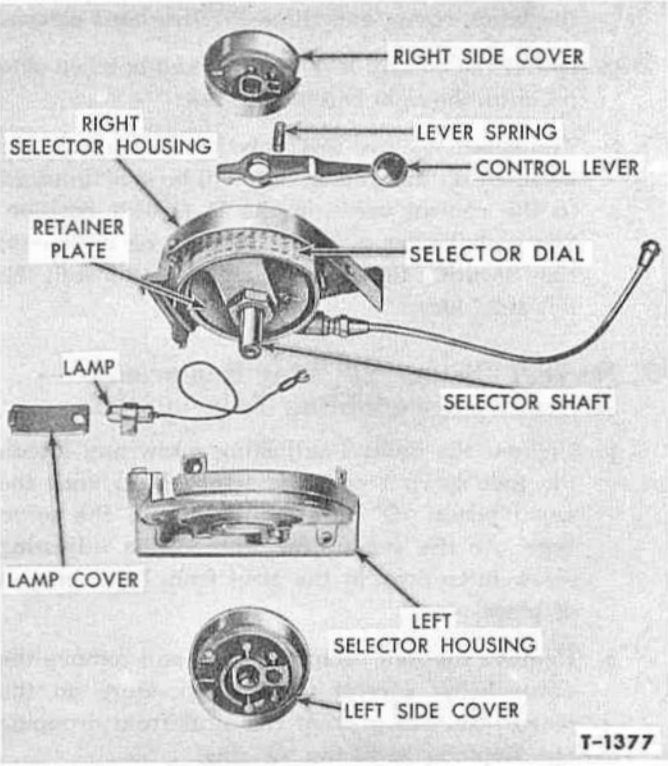


Figure 122—Selector Assembly Components

3. Inspect all parts of this assembly for damage and excessive wear.

O. Assembly of Speed Selector

1. Replace the shaft, bushing and retainer plate and secure with the snap ring after being certain the cable is engaged in the wheel.
2. Secure the conduit to the fitting and push or pull the cable until 1/4" of the cable connector is protruding from the conduit.
3. Install the indicator assembly and secure with the hex nut. Align the selector housing, install

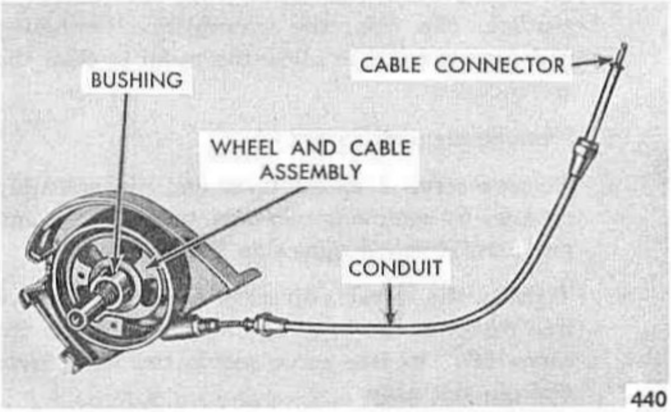


Figure 123—Servicing the Cable and Wheel Assembly

the lamp, cover, and three Phillips head screws.

4. Install the control lever, spring, and notched side cover on the right end of the shaft.
5. The speed selector assembly is now ready to be installed on the tractor, and will be synchronized to the control valve in the P (park) position. Some alignment of the cable may be necessary, then securely tighten the hex nut and install the left side cover.

P. Servo 1 Piston "O" Ring Replacement—Without Disassembling Transmission

1. Tighten the band 1 adjusting screw and loosen the four servo 1 cover attaching bolts until the servo piston "O" ring is just out of the servo bore. At the same time, thread the adjusting screw in to prevent the strut from dropping out of place.
2. Remove the four attaching bolts and remove the cover being careful to apply pressure on the servo piston to prevent the strut from dropping out. Replace the piston "O" ring.
3. Still applying pressure on the piston, install servo 1 cover and four attaching bolts. When tightening cover bolts, simultaneously loosen the adjusting screw to allow servo piston to move into place.
4. Adjust the band and check transmission pressures.

Q. Servo 2 Piston "O" Ring Replacement—Without Disassembling Transmission

1. Drain the transmission oil.
2. In order to remove the servo 2 and 3 cover, it will be necessary to either remove the roll pin from the feathering pedal and remove the pedal or remove the transmission cover and the cotter pin and clip from the transmission feathering pedal control rod to allow the pedal to clear the servo cover.
3. Remove the servo cover.
4. Remove servo 2 and 3 lever and pin assembly retainer by removing two nuts, two washers, and one bolt. Remove right side P.T.O. cover.
5. Tighten the band adjusting screw to remove free travel in the band and strut and rotate the servo 180° to free servo piston rod from lever and pin assembly.
6. Use a screwdriver under the end of the servo on the left side of the case to lift the servo out of the case.

   IMPORTANT: ***Do not allow the servo pin and lever assembly to move with the servo piston rod as it may result in dropping the strut and, in turn, make it necessary to disassemble the transmission.***
7. When replacing the servo 2 piston "O" ring, also remove and replace the rings on the piston rod guide. Remove the guide out of the left side of the transmission case by using a long carriage bolt and slide hammer.
8. Install the servo assembly.

   IMPORTANT: ***Be sure to engage the lever of servo 2 lever and pin assembly into the servo piston rod.***
9. Install servo 2 and 3 lever and pin assembly retainer and loosen band 2 adjusting screw.
10. Install servo 2 and 3 cover, oil inlet screen and feathering pedal or pedal control rod clip.
11. Fill the transmission with oil, check pressures, and adjust band 2.

R. Servo 3 Piston "O" Ring Replacement—Without Disassembling Transmission

1. Follow steps 1 through 3 under Servo 2 "O" Ring Replacement.
2. Loosen band 3 adjusting screw and remove servo 2 and 3 lever and pin assembly retainer by removing two nuts, two washers, and one bolt.
3. Without rotating servo 3, move the servo out of the case just enough to replace the piston "O" ring. Using the interlock valve on servo 3 as a handle, exert pressure on the piston to lift the opposite end of the servo so that the spring retaining washer will enter the land, and the servo assembly will be positioned correctly.
4. Install the servo lever and pin assembly retaining plate.
5. Install servo 2 and 3 cover, oil inlet screen and feathering pedal or pedal control rod clip.
6. Fill the transmission to the proper level with oil, operate unit, check pressures, and adjust band 3.

S. Torque Limiting Clutch

The torque limiting clutch shown in the insert, Figure 124, is removed for servicing by removing the six mounting bolts and lock washers. The individual members of the clutch assembly are shown in the insert, Figure 124. When installing the components, make sure the Belville washer is assembled with the concave (hollow) side forward. The pressure plate and the clutch disc is assembled with the hub adjacent to the clutch housing as shown.

INSTALLATION OF SUB-ASSEMBLIES

The transmission assembly procedure includes the installation of the sub-assemblies in the transmission case and checking transmission and P.T.O. end play. Do not use force to assemble mating parts. If the parts do not assemble freely, examine them for the cause of the difficulty. Always install new seals and gaskets during the assembly operation.

During the installation of the sub-assemblies, refer to Figure 102 for the proper location of all thrust washers.

A. Transmission Case Linkage

1. Install the feathering valve lever shaft assembly and secure with the two snap rings and the right Welsh plug. After valve body assembly is installed, check to see if feathering levers contact the center of valve spools, if not, drive the shaft and Welsh plugs to align. The Welsh plugs must be tight against shaft.
2. Install the inching pedal shaft and control rod, and secure with the retainer clips and cotter pin. Install the inching pedal on the shaft and insert the roll pin.
3. Install the P.T.O. interlock mechanism, ground speed P.T.O. shift lever and shifter fork in Model 81 transmissions and secure with the snap ring on the lever shaft and on the fork shaft. Insert the P.T.O. interlock flexible cable through the clamp in the feathering valve lever shaft linkage. The position of the cable within the clamp must be properly adjusted after the control valve is installed.
4. Install the engine speed P.T.O. shift lever assembly, minus the shifter fork, in Model 81 transmissions, and secure with the clevis pin and cotter pin.
5. Install the hydraulic lines in the transmission case. The P.T.O. line and the main pressure line must be extended through the front of the case

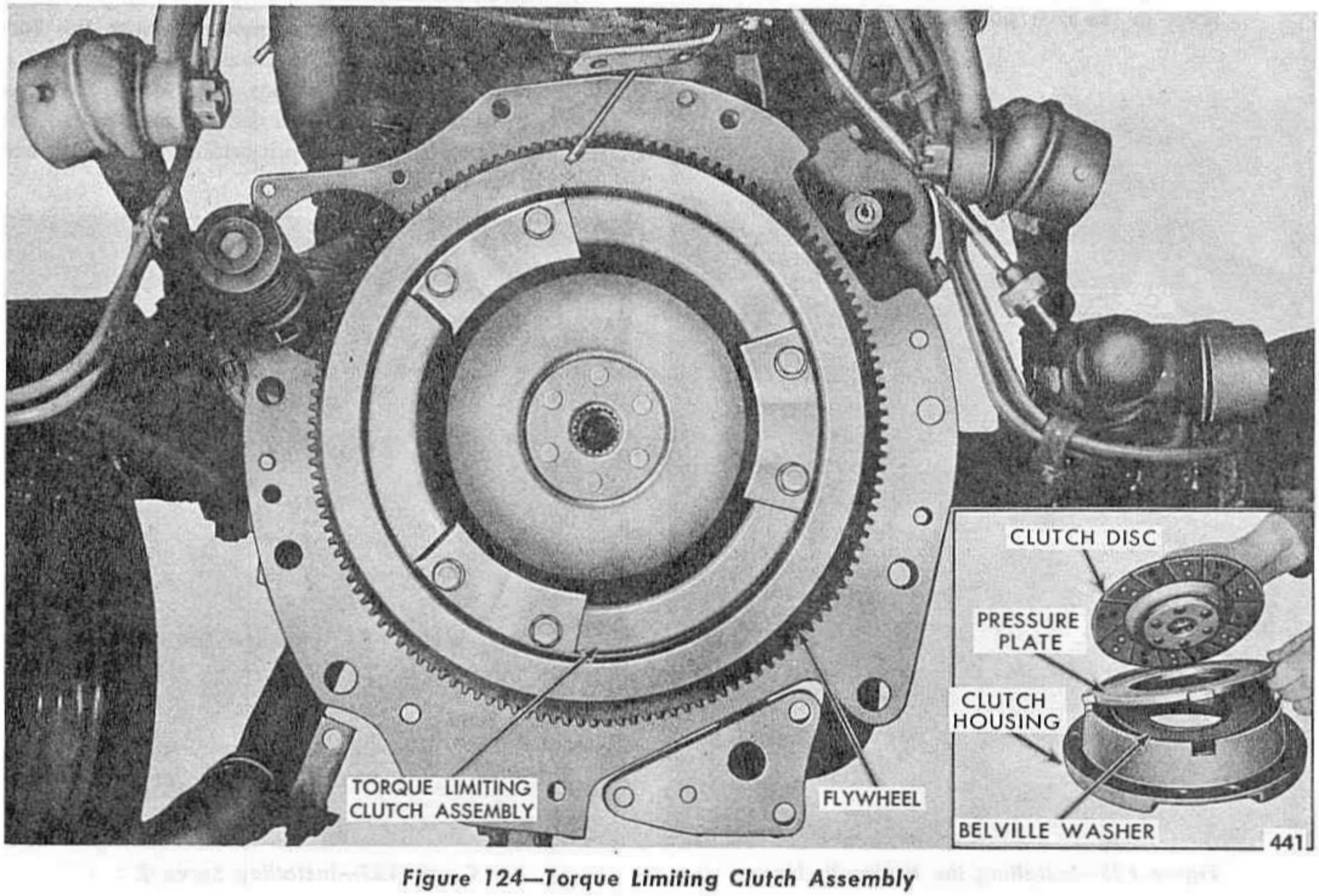


Figure 124—Torque Limiting Clutch Assembly

to permit "O" ring installation, as shown in Figure 125.

B. Installing P.T.O. System and Input Shaft

1. On model 81 transmissions, position the thrust washer in the front P.T.O. bevel gear and install this gear in the clutch pack. Center the shaft seals and insert the P.T.O. shaft into the clutch, while holding the bevel gear, as shown in Figure 126. Install the shim, spacer, and rear P.T.O. bevel gear on the shaft and install the assembly in the transmission case.
2. On model 71 transmissions, position the thrust washer in the P.T.O. clutch hub and install in the clutch pack. Install the clutch assembly in the transmission case. Then, center the shaft seals and insert the P.T.O. shaft into the clutch from the front of the transmission housing while holding the drive gear in place. Install the two snap rings on the P.T.O. shaft, one behind the clutch pack, the other at the rear end.
3. On model 81 transmissions, install the engine speed P.T.O. shifter fork with the long finger to the top. Position the engine speed P.T.O. shift lever in the rear position (1000 rpm).

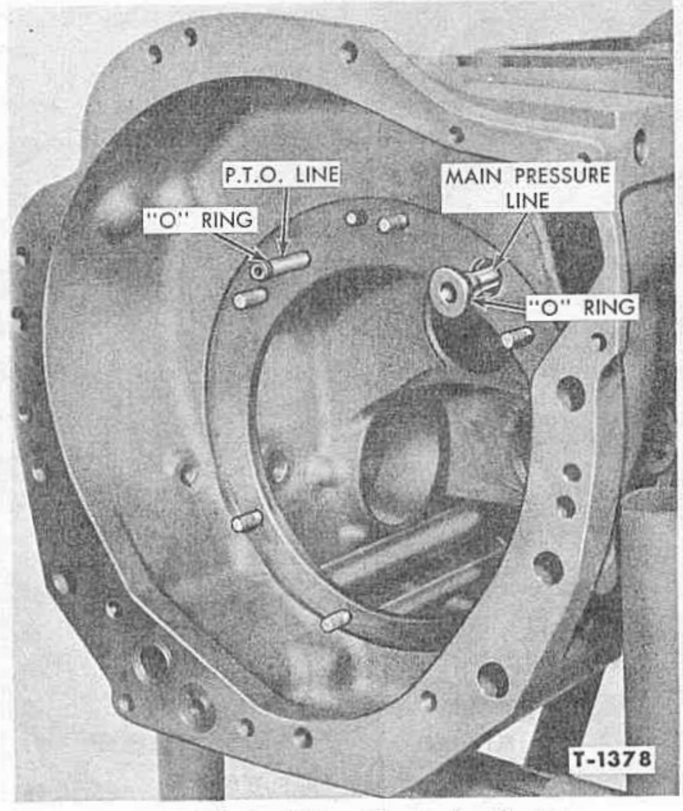


Figure 125—Installing the Hydraulic Lines

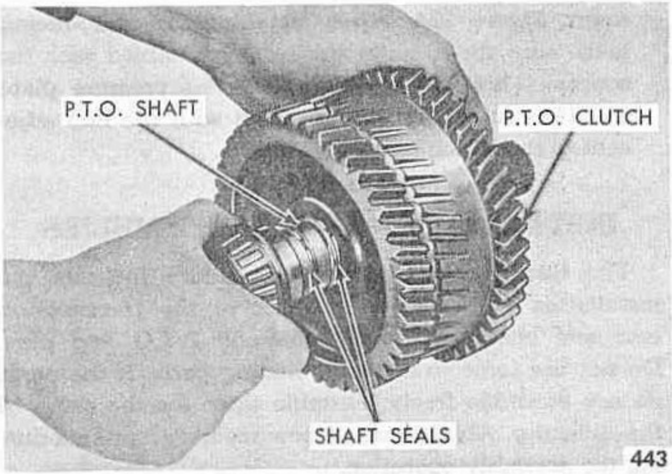


Figure 126—Installing the P.T.O. Shaft

4. Install the transmission input shaft assembly, being certain to fully insert the rear bearing in the transmission support web. Be sure the P.T.O. shifter fork engages the coupler on Model 81 transmissions.

C. Transmission Case Components Installation —Tractor Split at Rear

1. Install the servo 2 actuating lever and pin assembly and install servo 2 assembly with the bore and piston rod seal in place and the notch forward, as shown in Figure 127. Secure the lever pin in the retainer with the flat washer and nut, and install the lever pin retainer mounting bolt in the case.

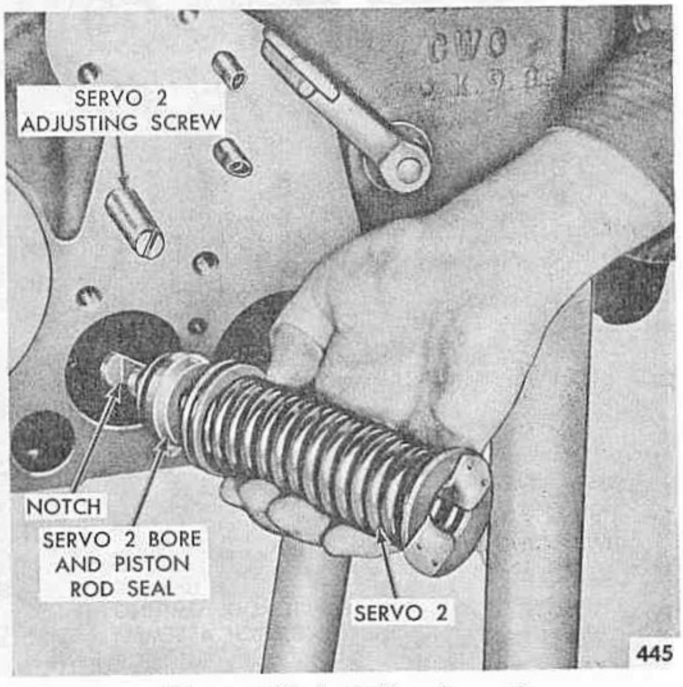


Figure 127—Installing Servo 2

2. Rotate band 2 around the center web of the transmission and secure in position, with the depression in the band end toward the adjusting screw. Join the band to the adjusting screw with the adjusting strut and to the servo lever with the actuating strut.
3. Install the thrust washer over the rear of the input shaft and install the "A" sun gear, overrunning clutch, and "A" carrier as an assembly. Install servo 1 and secure with the cover and seal. Tighten the four servo 1 cover bolts to 20-25 ft. lbs.
4. Install band 1 over the "A" sun gear, drum and secure with the adjusting screw and actuating strut, thin end toward the band. Position the thrust washer over the rear of the input shaft and install the "A" ring gear "B" sun gear. Then, place the thrust washer in the hub of "B" sun gear.
5. Install the selective thrust washer, shown in Figure 128, over the distributor shaft. Install and center the shaft seals.

   NOTE: ***If the transmission front end play was not within specifications when checked prior to disassembly, replace the washer with one of correct thickness. End play should be 0.005-0.015 inch.***
6. Position the "B" carrier with the thrust washer in place, "B" ring gear and clutch 1 assembly over the distributor shaft, as shown in Figure 128. Carefully insert the upper shaft seal into its groove with two screwdrivers to permit lowering the clutch. The lower shaft seal is locked, as shown, to facilitate entry into the clutch hub. Install this assembly in the transmission case being careful to align the two hydraulic lines (main supply and P.T.O.). The servo 1 tube may be installed after distributor installation is completed.

   On model 71 transmissions, position the "B" carrier with the thrust washer in place into the "B" ring gear and clutch 1 assembly and install in position in the case. For ease in installation, install two lock-type shaft seals on the distributor. Install the distributor by raising it over the servo 3 actuating lever and pin assembly, starting shaft seals in clutch 1 housing and moving it into position.
7. Start the four distributor mounting bolts. Then, insert the two servo fluid tubes into the distributor. Be certain that tubes are directing the fluid flow in the proper direction, and tighten the distributor mounting bolts to 20-25 ft. lbs. Attach the P.T.O. hydraulic line to the distributor.
8. Install servo 3 assembly, notch rearward, and the actuating lever and pin assembly. Secure the lever pin to the retainer with the flat washer and

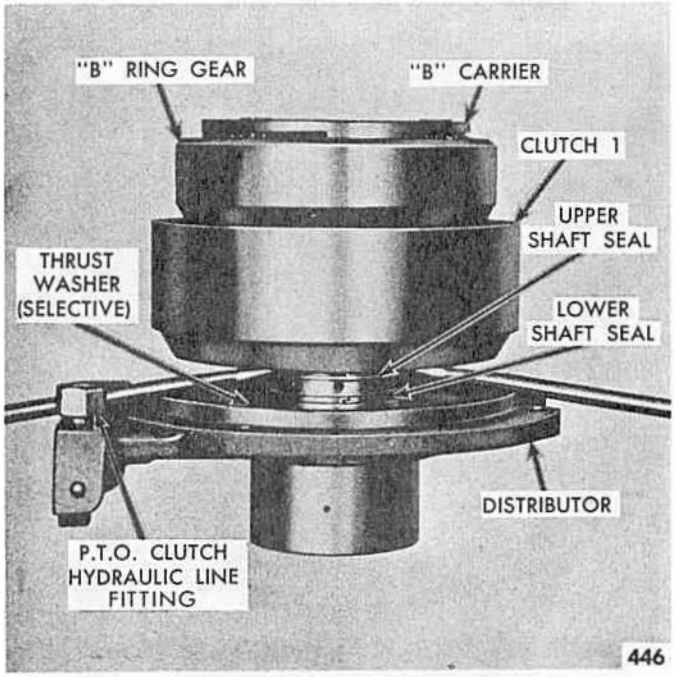


Figure 128—Installing the Distributor Shaft in Clutch 1

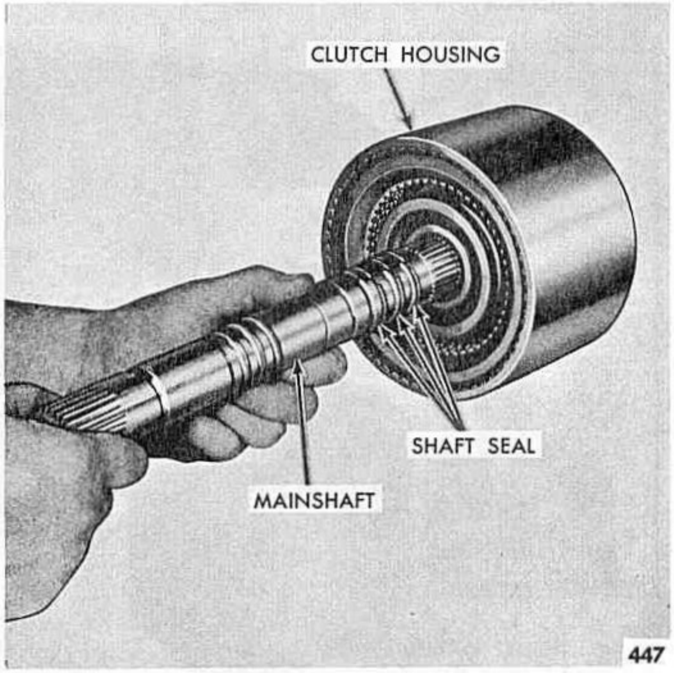


Figure 129—Installing the Mainshaft in the Clutch Housing

nut, then secure the retainer. Install the adjusting screw and secure band 3 in position, with the depression in the band end toward the adjusting screw. Join the band to the screw with the adjusting strut and to the servo lever with the actuating strut.

9. Install the servo interlock cover and gasket, making sure the check ball pin for servo 2 is in place in the cover. Install the strainer and plug assembly. Tighten the interlock cover attaching bolts evenly to 35-40 ft. lbs. Be certain flat washers and lock nuts have been installed on *all* band adjusting screws.

10. Install and center the three rearmost shaft seals on the mainshaft, and install the shaft in the housing for clutches 2 and 3, as shown in Figure 129. Position the thrust washer over the shaft and install the "C" carrier, as shown in Figure 130. Then, position the next thrust washer over the shaft.

11. Install and center the remaining four shaft seals on the mainshaft and install the "C" sun gear with its five shaft seals in place, as shown in the insert, Figure 130. Coat these seals with vaseline to hold them in place.

12. Install the thrust washer on the rear side of the distributor, and properly position the ground speed P.T.O. shifter fork (Model 81 transmission).

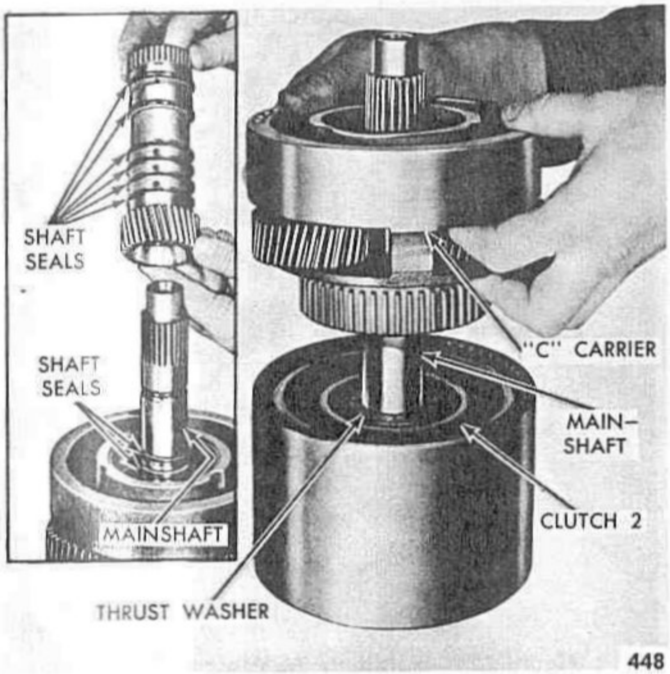


Figure 130—Installing the "C" Carrier in Clutch 2

13. Install the mainshaft, "C" sun gear, "C" carrier and clutch housings 2 and 3, as an assembly. Install the thrust washer on the rear of the mainshaft and install the "C" ring gear "D" sun gear assembly. Be certain the "D" sun gear is completely inserted into clutch 3.

14. Position the ground speed P.T.O. drive collar in the shifter fork (Model 81 transmission), and install the selective thrust washer in the "D" carrier, in the rear support.

    NOTE: ***If the transmission rear end play was not within specifications when checked prior to disassembly, replace the thrust washer with one of correct thickness. End play should be 0.005-0.015 inch.***

15. Install the rear support, "D" ring gear and gasket with the P.T.O. shaft in place on Model 81 transmissions, and over the P.T.O. shaft on Model 71 transmissions. Do not install the rear seal (Model 71 transmission). Tighten the five rear support attaching bolts to 35-40 ft. lbs. Clamp the P.T.O. interlock cable conduit by installing the external tooth lock washer and shield-nut on the top center rear support bolt.

D. Transmission Case Components Installation —Tractor Split at Front

1. Install the adapter plate and gasket, centering the P.T.O. shaft with a suitable tool, as shown in Figure 131. Tighten the nuts to 25-30 ft. lbs.

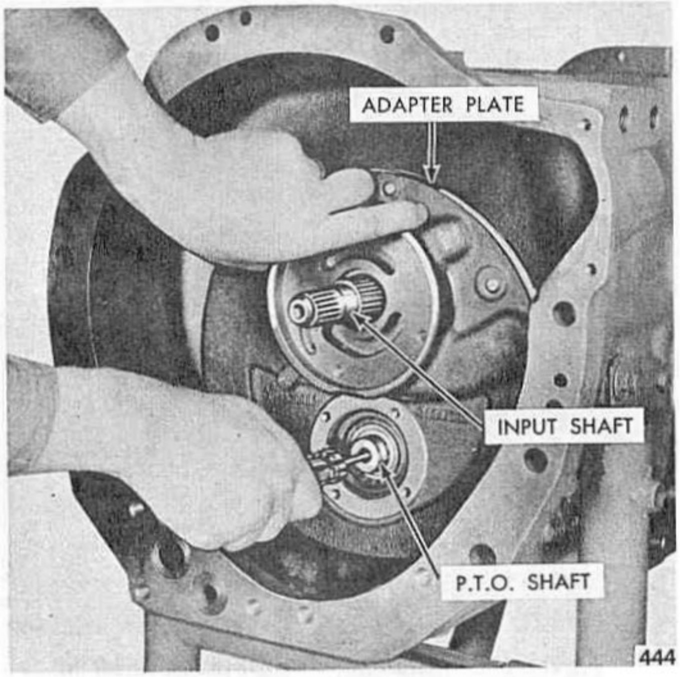


Figure 131—Installing the Adapter Plate

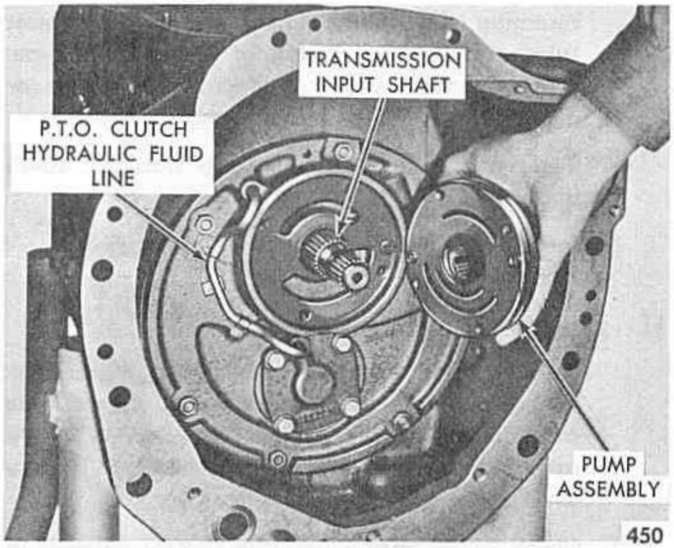


Figure 132—Installing the Pump

2. Install the pump to adapter plate gasket.
3. Install the pump carefully over the input shaft, as shown in Figure 132, and tighten the four pump mounting bolts to 15-18 ft. lbs.

E. Checking the P.T.O. Shaft Preload

1. On Model 81 transmissions, install the P.T.O. bearing retainer and tighten the four attaching bolts to 12-15 ft. lbs. Remove the right side cover, wrap a piece of cord around the shaft spacer, and attach it to a pull scale, as shown in Figure 133. The preload should be 18-25 lbs. when checked with Pull Scale 3600-E. Preload can be adjusted by varying the size and number of shims under the bearing retainer, as shown in the insert, Figure 133. Install the side cover and the front P.T.O. clutch hydraulic fluid line, shown in Figure 132.
2. On Model 71 transmissions, install the P.T.O. shaft cover and tighten the four attaching bolts to 12-15 ft. lbs. Remove the right side cover, wrap a piece of cord around the P.T.O. shaft and attach it to Pull Scale 3600-E, as shown in Figure 133. With the rear seal removed, the preload should be 18-25 lbs. when checked with the pull scale. Preload can be adjusted by varying the size and number of shims under the shaft cover, as shown in the insert, Figure 133. Install the P.T.O. shaft rear seal. Install the side cover and the P.T.O. clutch hydraulic fluid line, shown in Figure 132.

F. Control Valve Body Installation

The two retainers which secure the four adjusting screws in the valve upper body should not be installed, as the two regulating valves and the system relief must be properly adjusted during actual operation of the transmission.

1. Depress the transmission inching pedal and install the gasket and control valve body assembly.
2. Tighten the six valve mounting bolts to 5-8 ft. lbs. with the valve body in the park position.
3. Install the starter safety switch.
4. Install the oil filter or discharge tube.

   NOTE: ***After the transmission is installed, the control valve will have to be adjusted as outlined in the adjustment section of this manual.***

G. Filter Installation

1. Disconnect the feathering valve return spring.
2. Bend the ends of the cotter pin that attaches the feathering pedal upper actuating rod to the rocker, upward as far as possible, as shown in Figure 134, to prevent interference with the filter can.
3. Assemble the inlet tube and flange to the inlet end of the filter can marked "IN" with the clamp as shown in Figure 134. Make certain that the nuts of the retaining clamp are facing up and are loose enough to rotate the tube on the can.

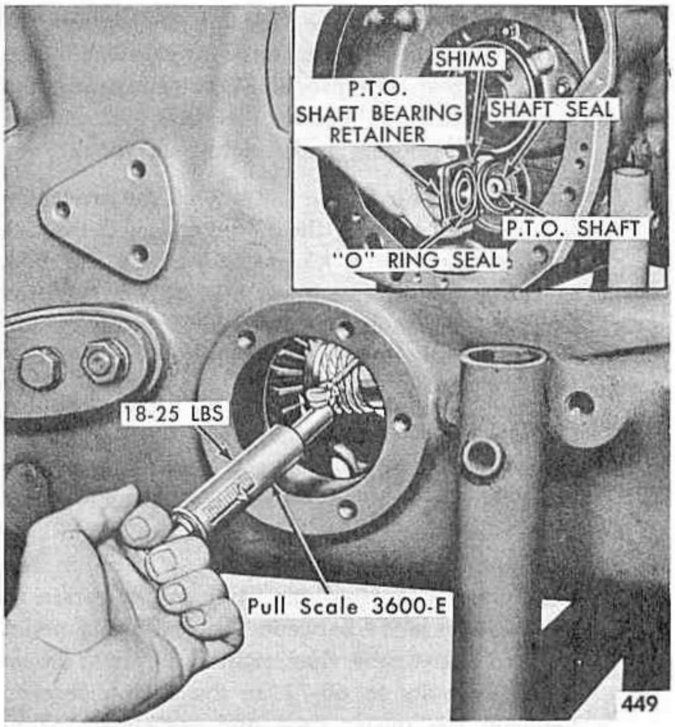


Figure 133—Checking P.T.O. Shaft Preload

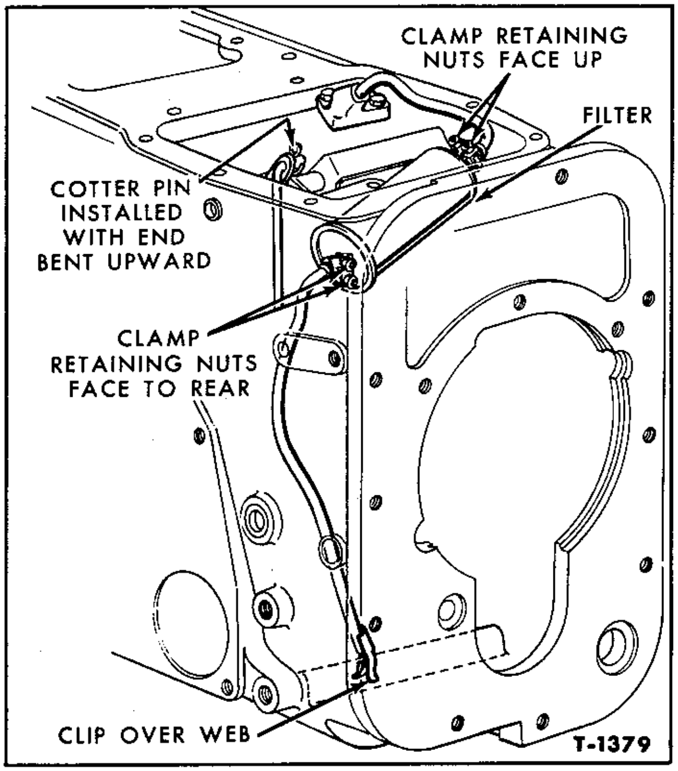

CLAMP RETAINING NUTS FACE UP
FILTER
COTTER PIN INSTALLED WITH END BENT UPWARD
CLAMP RETAINING NUTS FACE TO REAR
CLIP OVER WEB
T-1379

Figure 134—Oil Filter Installation

Secure the outlet tube to the filter can making sure that the clamp attaching nuts will be toward the rear of the transmission when the filter is installed. Tighten the two nuts securely.

4. Lower the outlet tube through the opening at the left rear of the transmission adjacent to the "C" ring gear. On Model 81 transmissions, the tube is positioned between the inner lock conduit and the feathering pedal actuating rod.

5. Locate the web in the bottom of the transmission case by moving the lower end of the outlet tube forward and back. After locating the web, seat the clip at the lower end of the tube, as near as possible to the center of the transmission and still have clearance between the outlet tube and "C" ring gear.

6. Position the new inlet tube gasket on the control valve upper body. Align the holes in the inlet tube flanges with those in the control valve. Install the two longer 1/4" bolts in the right side of the flange and the shorter 1/4" bolt in the remaining hole. Hold the filter in a position to provide clearance between the feathering pedal rod and outlet tube, then, tighten the three flange attaching bolts to 60-72 in. lbs. If interference between the outlet tube and feathering pedal rod is noted after tightening the bolts, move the retaining clip at the lower end of the outlet tube, toward the center of the transmission. Move the tube with a long screwdriver, just far enough to eliminate the interference.

7. Tighten the inlet tube clamp nuts to 30-40 in. lbs.

8. Install the feathering pedal return spring.

H. Transmission Cover Installation

NOTE: ***It is recommended that a new transmission cover gasket and conduit fitting seals be installed to prevent leakage during future operation. Be certain that the conduit fittings are tightened securely.***

1. Check to be certain that the control valve is in the (P) park position with all six spool-type valves in the valve lower body in the "OUT" position.

2. Thread the lower selector cable into the P.T.O. cable connector and guide the connector into the pilot while the cover is being lowered into place, as shown in Figure 135. When the cover is in position, move the cable up and down to be sure that the connector is moving freely within the pilot and install the cover bolts, but do not tighten them.

3. Remove the lower selector cable and start the P.T.O. control cable in the connector by turning

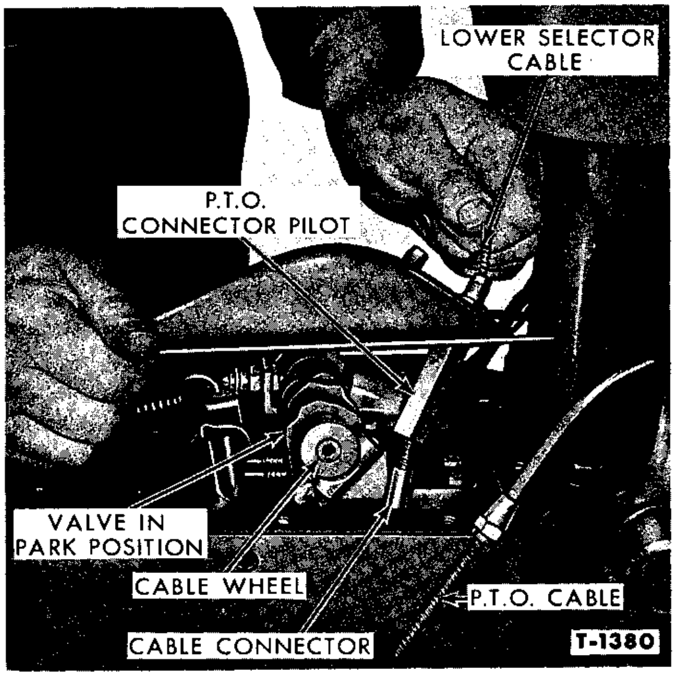


Figure 135—Transmission Cover Installation

the control handle counterclockwise. Once the cable is started, again check to be sure the connector is moving freely within the pilot.

4. Thread the P.T.O. cable into the connector until the lower end of the conduit contacts the cover fitting. Secure the P.T.O. control handle assembly to the tractor hood with the washer and jam nut. Be sure the tab in the hood is in the groove in the threads to hold the handle in a vertical position. Tighten the upper and lower conduit nuts securely. Check the P.T.O. control handle for ease of operation.
5. Thread the lower selector cable into the wheel in the control valve. If the cable does not turn freely, some slight movement of the cover is possible and, if necessary, the cover conduit fitting can be gently moved in the proper direction with a hammer and punch to obtain the proper alignment of cable and wheel. The cable must pass through the fitting freely to insure normal operation of the selector assembly.
6. Tighten the cover bolts and recheck the cable for freedom of rotation. Turn the cable as required to obtain a length of 2¾″ from the top of the fitting to the upper side of the notch in the cable connector, as shown in Figure 136. With the control valve in the (P) park position, this measurement will synchronize the control valve to the selector assembly.
7. Install the selector assembly with the selector lever in tenth speed. Attach the wires to the safety switch and selector lamp and connect the two flexible cables together. Now move the selector lever to the (P) park position which should bring the conduit down to contact the fitting in the cover.

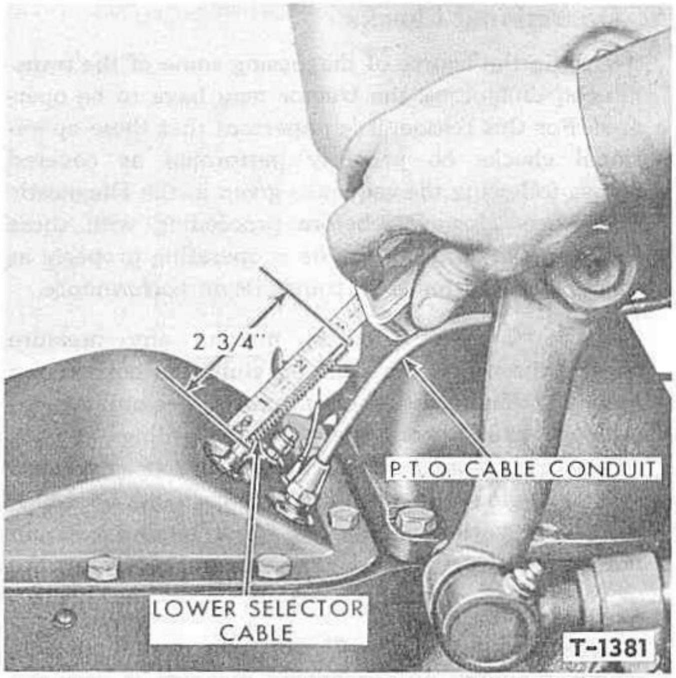


Figure 136—Installing Lower Selector Connector Cable

8. Secure the selector assembly to the hood with the four Phillips head screws, and tighten the lower conduit nut on the cover fitting.
9. Check the operation of the selector assembly for proper and complete selection of all speed ratios and, with the engine running at 800 rpm, check the P.T.O. control for normal operation. If the lubrication indicator lamp remains lighted, other than when the P.T.O. control handle is at a midway point in its travel, the cable is not sufficiently threaded into the connector. This situation results in the loss of transmission lubrication and slipping of the P.T.O. clutch. Adjustment of the P.T.O. control is necessary to obtain the proper synchronization.

10. TROUBLE SHOOTING SELECT-O-SPEED TRANSMISSION

A systematic procedure must be followed to locate the causes of an inoperative or malfunctioning transmission. The procedure consists of a series of mechanical, electrical and operational checks, designed to locate the specific area of difficulty.

However, depending upon the condition of the transmission, the problem may be easily diagnosed by following the checks covered in the preliminary checks or by using Table I of the Diagnosis Guide, Page 253. This guide lists the causes of various operational difficulties which are expressed in problem form. Table II of the Diagnosis Guide lists the possible causes of the general conditions given in Table I.

If the transmission problem is one of overheating or slippage in certain gear ratios, under loaded conditions, the more thorough Diagnostic Procedure should be followed which will include a complete pressure check of the system.

A. Operational Checks

During the course of diagnosing some of the transmission difficulties, the tractor may have to be operated. For this reason, it is important that these operational checks be properly performed as covered below, following the sequence given in the Diagnostic Procedure. However, before proceeding with these checks make sure the engine is operating properly as this is essential for good transmission performance.

Pressure Checks: Prior to making any pressure checks, disengage the traction clutch as covered on Page 217. The pressure check procedures are covered on Page 220. Record the pressure readings at each servo for each gear ratio. The pressure at each servo at 800 engine rpm and 120°F oil should be 180± 10 psi. A variation between servo readings should not exceed 3 psi. The regulating valve pressures are to read 150± 5 psi.

Torque Limiting Clutch Check: The torque limiting clutch, mounted on the engine flywheel is designed to slip under torques encountered from impact or shock loadings. If for any reason, it is suspected the torque clutch is not transmitting engine torque, a clutch slippage check can be made as follows:

1. Operate the tractor under load until the engine and transmission has reached the operating temperature at which the condition occurred.
2. Under a fully loaded condition, operate the tractor in 8th, 9th, or 10th gear at full throttle and quickly apply both brakes to simulate a shock loading and to slip the torque limiting clutch.
    a. If the engine pulls down to 1000 rpm and the engine stalls, the clutch is holding.
    b. If the brakes completely restrain the forward motion of the tractor and the engine does not lug down below 1000 rpm, torque limiting clutch slippage is indicated.

B. Preliminary Checks

The following preliminary checks should be performed before any thorough diagnosis is made. This will eliminate the loss of valuable time should these factors be the cause of difficulty.

1. Transmission Oil Level.
2. Traction Coupling Engaged.
3. Band Adjustment.
4. P.T.O. Handle Adjustment

C. Diagnostic Procedure

If, under any condition of normal transmission operation, whether under load or at specified idle speed, transmission malfunctioning is present, use this procedure. If the transmission is inoperative, refer to Table I Diagnosis Guide. Primarily, the Diagnostic Procedure is based on the use of the lube light to segregate the general source of difficulty. Then, if it is found that after making the pressure checks that incorrect pressures are evident, the lube light is then used in conjunction with these readings to establish five possible Hydraulic Conditions. These hydraulic conditions can be used for determining the nature of the problem. In the case of Hydraulic Condition 5, the Trouble Shooting Chart is to be used to further segregate the area of difficulty.

If the lube light remains ON, check the following:

1. Low oil level.
2. Shorted lube circuit electrical connections or defective sender switch.

*3. Low circuit pressures.

NOTE: ***If the lube light comes on in certain gear ratios perform the pressure check and refer to Hydraulic Condition 5.***

If the lube light remains OFF, check the following:

1. Broken electrical connection or defective fuse (only prior to engine starting up).
2. Band adjustment.
3. Traction coupling.

*4. Excessive or improperly adjusted circuit pressures.

*Perform pressure checks and proceed to Hydraulic Condition applicable.

NOTE: ***If the pressures are to specification and rough shifting characteristics exist, check control valve alignment, overrunning clutch operation, and regulating valve pressure setting.***

D. Hydraulic Conditions

Pressures are to specification but lube light remains ON:

1. Lube relief valve stuck open or improperly adjusted.
2. Excessive transmission end clearances.
3. Restriction in the lube circuit.

4. Broken shaft seals.
5. Defective sender switch.

All pressures are above specification:

1. System relief valve improperly adjusted.

All pressures are below specification and lube light remains OFF:

1. System relief valve stuck open.
2. Other system problems in conjunction with defective lube sender circuit.

All pressures are below specification and lube light remains ON:

1. Plugged suction screen or restricted input line.
2. Defective pump or gasket.
3. Defective pressure line or "O" rings.
4. Leaking or missing valve body gasket.
5. Leaking between valve body halves.
6. P.T.O. control knob linkage adjustment.
7. B_2 or B_3 spool valve missing.
8. Torque limiting clutch.

Pressures are below specification in certain gear ratios where lube light is ON:

1. Observe in which gear ratios low pressure readings occur.
2. Fully depress the inching pedal in the gear ratios where low pressure readings occur and note the lube light and pressure readings on servos 2 and 3.
   a. If the pressure increases and the lube light goes OFF, leakage is occurring in the transmission indirect circuit which consists of circuits for C_1, C_2, C_3, and B_1.
   b. If the pressures at B_2 and for B_3 remain low, leakage is occurring in the direct circuit of which servo 2 and servo 3 are a part.
3. Use the Trouble Shooting Chart on Page 252 and note which servos and clutch packs are pressurized for the gear ratios where low pressure readings are occurring. A process of elimination will pin point which servo, or clutch is leaking.
4. If it is noted that consistent low pressures exist in the gear ratios where either C_1, C_2, C_3, and B_1, is pressurized, the following items should be checked:
   a. Improperly assembled transmission feathering valve.
   b. Spool valve missing from circuits C_1, C_2, C_3, or B_1.
   c. Leaking valve body gasket.

E. Diagnosis Guide and Trouble Shooting Chart

The Trouble Shooting Chart shows the application of the various clutch packs and bands, as well as the overrunning clutch for each gear ratio. The applied unit is indicated by the bold letter "A".

Should the band or clutch for some reason be inoperative either constantly applied or released, transmission malfunctioning will result. Either of these conditions can be determined by using the "a-applied, does not release" or the "r-released, does not apply" columns under the element involved in conjunction with the "inoperative" lines included with each gear ratio. Thus, if the tractor is operative in some gears, inoperative in others, and locks up, i.e., stalls the engine in the remainder, the vertical columns under "a" and "r" should be checked to determine which column corresponds with the conditions encountered.

To diagnose this condition, operate the tractor at idle speed with the inching pedal fully depressed. Observe the transmission operation in each gear ratio by gradually releasing the inching pedal.

If the Trouble Shooting Chart is used in conjunction with the pressure checks, the band or clutch columns must be approached solely from a hydraulic pressure application standpoint whether the element itself is applied or released. The pressure applications on the chart are indicated by the shaded areas. Thus, for the 3rd gear ratio, pressure is applied to band 1 servo, band 2 servo, and clutch pack 3.

Since the pressure checks are made only at the band servos, it is necessary to compare the low pressure readings obtained in the various gear ratios with the shaded areas on the chart in order to form a pattern. This, of course, is done following the procedure covered in Hydraulic Condition 5 in the Diagnostic Procedure.

For example, low pressure readings are noted in: Reverse 1, Reverse 2, 9th, and 10th.

The feathering pedal is depressed as covered in B (1) of condition 5 and the lube light goes out and pressures at band servos 2 and 3 increase. Since only the above gear ratios are affected, and since only the indirect circuit is involved, it is readily indicated by shaded areas on the chart that clutch pack 1 is the element involved. Thus, the leak is occurring only in the clutch 1 circuit.

TROUBLE SHOOTING CHART

GEAR RATIO	OVERRUNNING CLUTCH			BAND									CLUTCH PACK								
				I.C.			D.C.						I.C.								
				1 *			2 * *			3 * *			1 *			2 *			3 *		
	a		r	a		r	a		r	a		r	a		r	a		r	a		r
PARK (P) INOPERATIVE	P	A	P	P		P	P	A	N	P	A	N	L		P	L		P	L		P
R_2 INOPERATIVE	L		R_2	R_2	▨ A	R_1	L	▨	R_2	R_2	A	N	R_2	▨ A	N	L		R_2	L		R_2
R_1 INOPERATIVE	R_1	A	N	R_2		R_1	L	▨	R_1	R_1	A	N	R_1	▨ A	N	L		R_1	L		R_1
NEUTRAL (N) INOPERATIVE	N	A	N	N		N	P	▨	N	N	A	N	R_1		N	2		N	1		N
1st INOPERATIVE	1	A	N	3		1	L	▨	1	1	A	N	L		1	L		1	1	▨ A	N
2nd INOPERATIVE	2	A	N	4		2	L	▨	2	2	A	N	L		2	2	▨ A	N	L		2
3rd INOPERATIVE	L		3	3	▨ A	1	L	▨	3	3	A	N	L		3	L		3	3	▨ A	N
4th INOPERATIVE	L		4	4	▨ A	2	L	▨	4	4	A		L		4	4	▨ A	N	L		4
5th INOPERATIVE	5	A	N	7		5	5	A	N	L	▨	5	L		5	L		5	5	▨ A	N
6th INOPERATIVE	6	A	N	8		6	6	A	N	L	▨	6	L		6	6	▨ A	N	L		6
7th INOPERATIVE	L		7	7	▨ A	5	7	A	N	L	▨	7	L		7	L		7	7	▨ A	N
8th INOPERATIVE	L		8	8	▨ A	6	8	A	N	L	▨	8	L		8	8	▨ A	N	L		8
9th INOPERATIVE	9	A	N	10		9	L	▨	9	L	▨	9	9	▨ A	N	9	▨ A	N	9		9
10th INOPERATIVE	L		10	10	▨ A	9	L	▨	10	L	▨	10	10	▨ A	N	10	▨ A	N	10		10

A—The unit is applied
L—Lock-up

P—Park
N—Neutral

a—Applied, does not release
r—Released, does not apply

*Pressure applied-indirect circuit
**Spring applied-direct circuit

▨ Hydraulic pressure on

TABLE I

DIAGNOSIS GUIDE

Problem	Condition
1. Transmission remains in Park	1. a. Low fluid pressure b. Bands 2 and/or 3 not released c. Damaged or broken selector cable
2. Transmission goes to Neutral	2. a. Band 2 or 3 released b. Clutch packs not engaged c. Traction coupling disengaged d. Damaged or broken selector cable
3. Transmission functions in all selector positions, but can be held in tenth speed, without stalling the engine (1500 rpm), when brakes are applied	3. a. Low fluid pressure b. Defective torque limiting clutch
4. Transmission functions in Reverse only	4. Mainshaft broken or damaged spline on "B" carrier
5. Transmission functions in 3, 4, 7, 8, 10 and R_2 only	5. Overrunning clutch does not apply
6. Transmission functions in all selector positions but provides the direct ratios only	6. Band 1 does not apply
7. Transmission goes to Neutral in Park, 5, 6, 7 and 8	7. Band 2 does not apply
8. Transmission goes to Neutral in Park, 1, 2, 3, 4, R_1 and R_2	8. Band 3 does not apply
9. Transmission goes to Neutral in 9, 10, R_1 and R_2	9. Clutch 1 does not apply
10. Transmission goes to Neutral in 2, 4, 6, 8, 9 and 10	10. Clutch 2 does not apply
11. Transmission goes to Neutral in 1, 3, 5 and 7	11. Clutch 3 does not apply
12. Transmission locks up in 3, 4, 7, 8, 10 and R_2	12. Overrunning clutch does not release
13. Transmission functions in all selector positions but provides the overdrive ratios only	13. Band 1 does not release
14. Transmission locks up in 1, 2, 3, 4, 9, 10, R_1 and R_2, and goes to Park in Neutral	14. Band 2 does not release
15. Transmission locks up in 5, 6, 7, 8, 9 and 10	15. Band 3 does not release
16. Transmission locks up in Park, 1, 2, 3, 4, 5, 6, 7 and 8 and goes to R_1 in Neutral	16. Clutch 1 does not release
17. Transmission locks up in Park, 1, 3, 5, 7, R_1 and R_2 and goes to 2 in Neutral	17. Clutch 2 does not release
18. Transmission locks up in Park, 2, 4, 6, 8, 9, 10, R_1 and R_2 and goes to 1 in Neutral	18. Clutch 3 does not release

TABLE II

DIAGNOSIS GUIDE

Condition	Possible Cause	
1. Low Pump Fluid Pressure	1. a. Low fluid level b. Plugged suction screen or incorrectly installed c. Pump gasket leaking d. Pump pressure line or "O" ring leaking e. Defective torque limiting clutch	f. Defective pump g. Leakage between valve body halves h. Leaking valve body gasket i. System relief valve stuck open j. Restricted pressure line
2. Overrunning Clutch Inoperative (Does not apply) (Does not release)	2. Defective unit	
3. Band 1 Inoperative (Does not apply)	3. a. Band too loose—adjust b. Band strut out c. Leakage between valve body halves d. Leaking valve body gasket	e. Pressure line leaking f. Leaking servo "O" rings g. Scoring or burring of servo
(Does not release)	a. Band too tight—adjust b. Servo return spring broken or defective	c. Band spool valve stuck d. Scoring or burring of servo
4. Band 2 or 3 Inoperative (Does not apply)	4. a. Band too loose—adjust b. Band strut out c. Servo spring broken or defective	d. Scoring or burring of servo e. Servo spool valve stuck
(Does not release)	a. Band too tight—adjust b. Leaking valve body gasket c. Leakage between valve body halves	d. Fluid line "O" rings leaking e. Leaking servo seals f. Scoring or burring of servo
5. Clutch 1 Inoperative (Does not apply)	5. a. Leaking valve body gasket b. Leaking piston "O" rings c. Mainshaft seals	d. "C" sun gear seals e. Distributor seals f. Scored or burred piston
(Does not release)	a. Clutch spool valve stuck b. Scored or burred piston	c. Broken or defective clutch spring d. Warped or defective clutch discs
6. Clutch 2 or 3 Inoperative (Does not apply)	6. a. Leaking valve body gasket b. Leaking piston "O" rings c. Mainshaft seals d. "C" sun gear seals	e. Mainshaft core loose f. Broken mainshaft g. Leakage between valve body halves h. Scored or burred piston
(Does not release)	a. Clutch spool valve stuck b. Scored or burred piston	c. Broken or defective clutch spring d. Warped or defective clutch plates

11. SPECIFICATIONS

FOUR SPEED TRANSMISSION

Gear Ratios

1st	11-1
2nd	9.06-1
3rd	6.22-1
4th	2.98-1
Reverse	10.50-1

Preload

Countershaft	15-30 in. lbs.
Mainshaft	20-35 in. lbs.

Oil Capacity	6 U. S. Quarts

SHERMAN STEP-UP AND STEP-DOWN TRANSMISSION

Gear Ratios

Step-Down 1st	16.5-1
Step-Down 2nd	13.7-1

Gear Ratios—Cont'd

Standard 1st	11-1
Step-Down 3rd	9.3-1

SHERMAN STEP-UP AND STEP-DOWN TRANSMISSION—*Cont'd*

Gear Ratios—Cont'd

Standard 2nd	9.06-1
Step-Up 1st	7.2-1
Standard 3rd	6.22-1
Step-Up 2nd	5.9-1
Step-Down 4th	4.4-1
Step-Up 3rd	4.1-1
Standard 4th	2.98-1

Gear Ratios—Cont'd

Step-Up 4th	1.9-1
Step-Down Reverse	15.7-1
Standard Reverse	10-50-1
Step-Up Reverse	6.9-1

Oil Capacity

Initial Fill	1 U. S. Quart

SHERMAN REVERSING TRANSMISSION

Gear Ratios

Direct	1-1

Oil Capacity

Initial Fill	1 U. S. Quart

FIVE SPEED TRANSMISSION

Gear Ratios

1st	17.55-1
2nd	11.04-1
3rd	8.31-1
4th	6.02-1
5th	3.38-1
Reverse	10.29-1

Preload—Single Clutch

Countershaft	7-10 lbs.*
Mainshaft	10-12 lbs.**

Preload—Double Clutch

Countershaft	7-10 lbs.*
Mainshaft	8-10 lbs.**

*Cord wrapped on countershaft final drive.

**Cord wrapped on main cluster gear (between gears).

Oil Capacity	**8 U. S. Quarts**

SELECT-O-SPEED TRANSMISSION

NOTE: ***All specifications are given in inches, unless otherwise noted.***

GENERAL

End Play

Front Transmission	0.005-0.015
Rear Transmission	0.005-0.015
Planet Pinion Gears	0.008-0.025

Preload

P.T.O. Shaft Bearings	18-25 lbs. pull

General—Cont'd

Servo Bore Diameter

Servo #1	1.999-2.001
Servo #2	2.125-2.127
Servo #3	3.000-3.002

Planet Gear Bore Diameter

A, B, C	0.8063-0.8068
D	1.1062-1.1067

General—Cont'd

Planet Gear Shaft Diameter

A, B, C	0.5557-0.5560
D	0.7930-0.7934

Band Adjustments

Band #1	One Turn
Band #2	¾ Turn
Band #3	¾ Turn

Thrust Washers

Standard	0.061-0.063
Selective–Front	0.062-0.122
Selective–Rear	0.092-0.152

(Selective Washers are available in increments of 0.010)

HYDRAULIC SYSTEM

Reservoir

Fluid Specification	M2C41 Hydraulic Fluid
Location	Transmission Case
Capacity	11.5 Quarts

Pump

Type	Roller Vane
Capacity	10 gpm @ 2000 rpm and 200 psi (175° F.)

Control Valve Body

Valve Spool Diameters	0.3738-0.3742
Bore Diameters	0.3751-0.3758
Trunnion Diameter–Left	0.4350-0.4355
Trunnion Diameter–Right	0.437-0.443
Valve Body Flatness	0.0003 T. I. R.

Valve Spring Free Lengths

Feathering Valves (2)	1.110-1.130
Detent (1)	0.98 Approximately
Spool Return (6)	1.240 Approximately
System Relief (1)	2.02 Approximately
Regulating (2)	2.02 Approximately
Lubrication (1)	1.450 Approximately

Hydraulic Pressures @ 800 Engine rpm and 120° F. Fluid Temp.

System Relief	180 psi ± 10 psi
Regulating (Partial Feather)	150 psi ± 5 psi
Lubrication (At Rear Support)	2 psi Minimum

TORQUE LIMITING CLUTCH

Belleville Spring–Thickness	0.084-0.086
Belleville Spring–Dish (Free)	0.195-0.205
Drive Plate with Lining Thickness	0.333-0.347
Flywheel Depth	2.026-2.032
Pressure Plate Thickness	0.278-0.282

BUSHING DIAMETERS

"A" Sun Gear	1.249-1.250
Clutch #1 Housing	2.2178-2.2188
"C" Carrier–Front	3.0615-3.0625
"C" Carrier–Rear	1.374-1.375
"D" Sun Gear	0.999-1.000
Rear Support	1.749-1.750
P.T.O. Driven Gear–Front	1.874-1.875
P.T.O. Driven Gear–Rear	1.624-1.625

OUTPUT SHAFT SPEEDS @ 1750 ENGINE RPM

Speed	Output Shaft rpm
R2	–202
R1	–137
N	(Slight Creep Possible)
1	46
2	65
3	68
4	97
5	155
6	200
7	230
8	295
9	478
10	709

TORQUE SPECIFICATIONS

	Torque In Ft. Lbs.
Valve Body Mounting Bolts	5-8
P.T.O. Bearing Retainer Bolts	12-15
Pump Mounting Bolts	15-18
Adapter Plate Nuts	25-30
Distributor Attaching Bolts	20-25
Rear Support Mounting Bolts	35-40
Interlock Cover Attaching Bolts	35-40
Servo #1 Cover Attaching Bolt	20-25
Servo Actuating Lever Pin Nuts	100-120
Lever Pin Retainer Bolt	90-110
P.T.O. Hydraulic Fluid Line Fitting to Distributor	10-12
Torque Limiting Clutch Mounting Bolts	25-30
Transmission Cover Attaching Bolts	18-23

12. SPECIAL TOOLS

The following special tools are required to disassemble and assemble the tractor transmissions.

Four Speed Transmission

Tool No.	Description
P-61	Ratchet Wrench
630-S	Step Plate Set (No. 1-11)
630-T	Step Plate Set (No. 12-17)
930-B	Extensions
938	Push Puller
943	Bearing Cup Pulling Attachment
943-S	Slide Hammer
951	Bearing Pulling Attachment
956-2	Pilot Bearing Puller
1002	Puller
1003	Puller
4609-A	Preload Gauge
7227	Shift Lever Spring Compressor
▲▲	Sleeves (Suitable)

Sherman Transmissions

Tool No.	Description
630-S	Step Plate Set (No. 1-11)
630-T	Step Plate Set (No. 12-17)
943-S	Slide Hammer
956-2	Pilot Bearing Puller
10A747A	Test Collar

Five Speed Transmission

Tool No.	Description
630-S	Step Plate Set (No. 1-11)
630-T	Step Plate Set (No. 12-17)
818	Bushing Driver Set
T-818	Heavy Duty Bushing Driver Set
943	Bearing Cup Pulling Attachment
951	Bearing Pulling Attachment
956-2	Pilot Bearing Puller
3600-E	Pull Scale
▲▲	Sleeves (Suitable)

Select-O-Speed Transmission

Tool No.	Description
N-774-A	Pressure Gauge (0-300 psi)
N-775	Compressor
630-S	Step Plate Set (No. 1-11)
943	Bearing Cup Pulling Attachment
943-S	Slide Hammer
▲▲	Dial Indicator
▲▲	Offset Screwdriver (Fabricated)

Part TWO

CLUTCH, TRANSMISSIONS, REAR AXLE AND POWER TAKE-OFF

Chapter

III

REAR AXLE

Section		Page
1.	General Purpose and Industrial Tractors	258
2.	Row Crop Tractors	266
3.	Center Housing Replacement	270
4.	Specifications	272
5.	Special Tools	272

1. GENERAL PURPOSE AND INDUSTRIAL TRACTORS

The procedure for repairing the differential, pinion, and axle housing is similar for "General Purpose," "Industrial," and "Row Crop" tractors and is covered in Section 1.

The disassembly procedure for the "General Purpose" and "Industrial" tractor rear axle and center housing assembly is broken down into five parts: Wheel Bolt Replacement, Axle Shaft, Axle Housing, Differential Overhaul, and Pinion Overhaul. Information on repairing the center housing is covered in "Center Housing Replacement," Section 3.

The following is a complete disassembly of the rear axle and center housing. However, in most cases it is not necessary to disassemble the entire axle assembly to repair or replace the damaged components. Notations are used where different procedures are required for a specific model tractor.

A sectional top view of the rear axle and center housing is shown in Figure 1. Additional figures are used throughout the copy to illustrate some of the special tools required.

WHEEL BOLT REPLACEMENT

The procedures below apply only with the axle shaft installed in the tractor. If the axle shaft is going to be disassembled, the bolts should be replaced at that time.

A. Removal

1. Remove the rear wheel and brake drum.
2. Drive out the knockout plug in the brake backing plate.
   NOTE: ***On tractors prior to Serial No. 45058, it is necessary to drill a 1" hole in the brake backing plate directly behind the wheel bolt circle. In some instances, it may also be necessary to remove material from the retainer housing to provide sufficient clearance for the bolt head.***
3. Line up the damaged wheel bolt and drive it out through the opening in the backing plate.

B. Installation

1. Install new wheel bolts making sure that the serrations on the bolts align with those in the holes.
2. Plug the hole in the brake backing plate with a button plug to keep dirt out.
3. Install the brake drum and the wheel.

AXLE SHAFT

The shaft and side gear on early production tractors have been replaced on later model tractors with parts having a different type spline. This change was effective at Serial No. 49095 on Series 601 Tractors and Serial No. 48642 on Series 801 and 1801 Tractors. When the old shaft, or side gear, is replaced with the new part, its mating part must also be replaced.

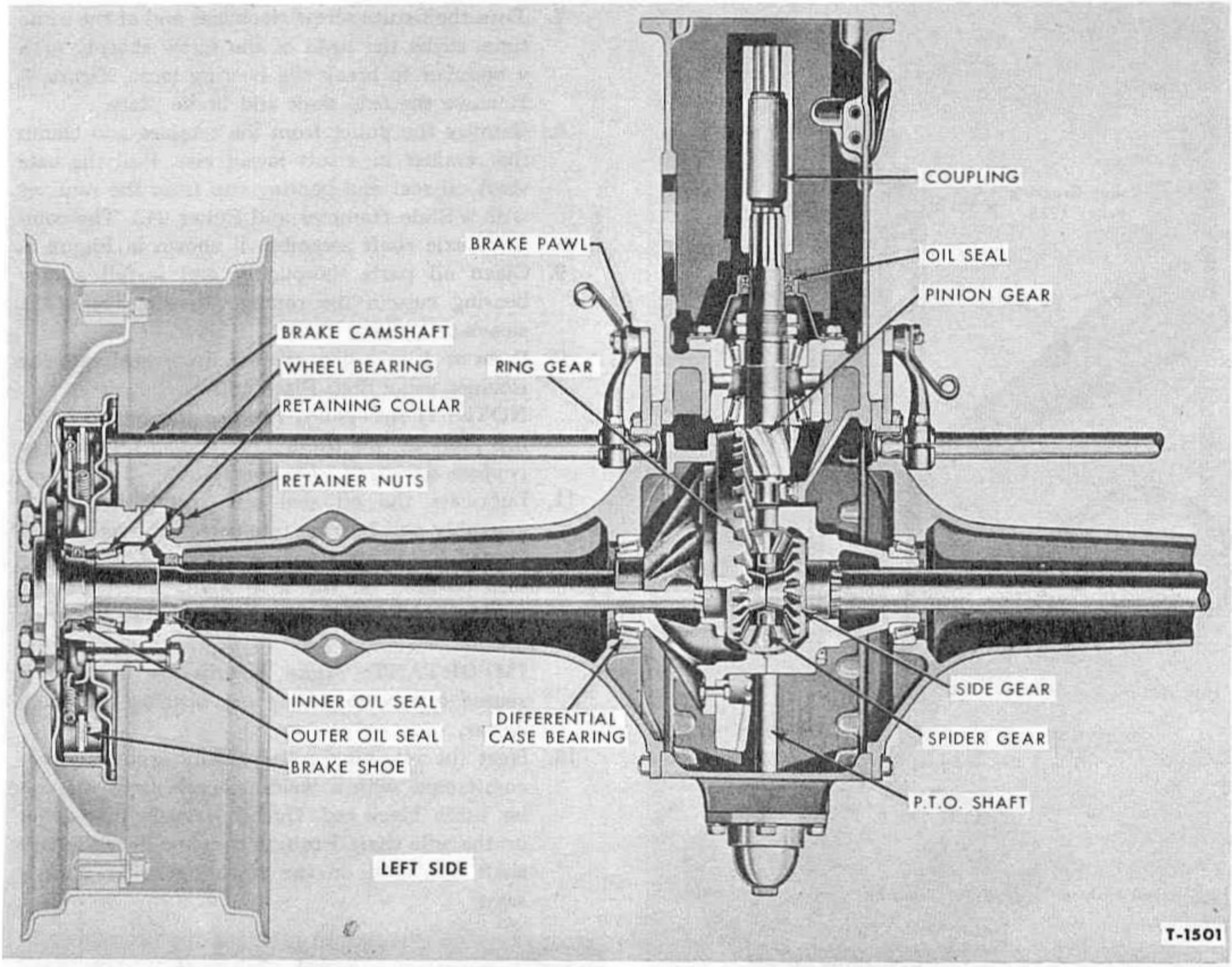


Figure 1—Rear Axle Used on General Purpose Tractors

A. Removal

1. Drain the differential section of the rear axle center housing. Loosen the rear wheel nuts.
2. Place a jack under the center housing and raise the tractor. Remove the rear wheels.
3. Remove the brake drum attaching bolts or speed nuts and remove the drum.

Left Axle: Remove the brake control rod clevis pin.

4. Remove the axle housing to bearing retainer housing nuts and lock washers, Figure 1.
5. Remove the axle shaft, brake, and bearing retainer as an assembly. When the cam end of the brake shaft frees the brake shoes, turn the shaft 90° to pass through the brake backing plate.
6. Remove the shim pack and tag it for reassembly.

B. Axle Shaft Bearing and Oil Seal Replacement

1. Protect the stud threads by placing the axle shaft assembly in a vertical position over a wood block.
2. Install the Collar Cracking Puller, NCA-4235, on the bearing retainer as shown in Figure 2. Use a 9/32″ drill bit, and drill a pilot hole through the collar.

> NOTE: ***The drill motor will speed up when the drill bit strikes the hardened surface of the bearing retainer. This indicates that the drill bit is through the collar.***

3. After drilling the pilot hole, position the drill fixture so the ½″ guide is over the pilot hole.

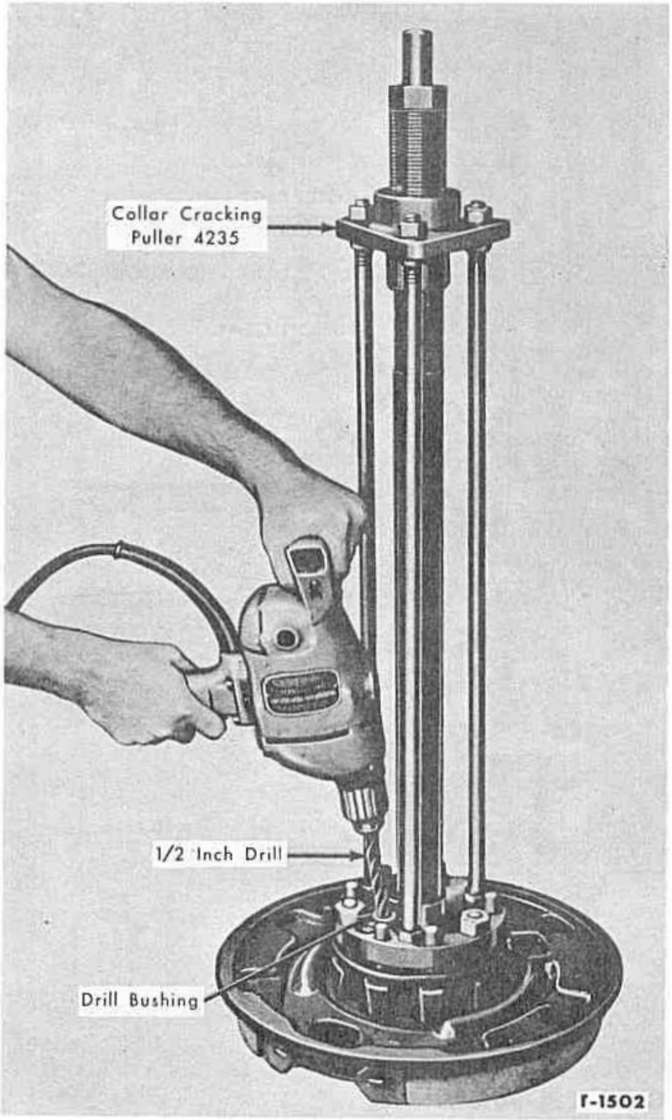


Figure 2—Drilling Hole in Bearing Retaining Collar

Use a ½″ drill bit and enlarge the pilot hole. Drill slowly and move the bit in and out to free the chips.

4. Position the fixture so that the largest guide hole is over the drilled hole. Install the Cracking Chisel, NCA-4235-A1, Figure 3, in the hole so that the round side of the chisel faces the bolt circle.

   IMPORTANT: *The forward cutting edge of the cracking chisel must face toward the axle shaft.*
5. Use a heavy hammer and drive the chisel until the collar splits.
6. Install the puller and axle shaft assembly in a vise.
7. Turn the fixture screw clockwise and at the same time, strike the head of the screw sharply with a hammer to break the bearing loose, Figure 4. Remove the axle shaft and brake plate.
8. Remove the puller from the retainer and clamp the retainer in a soft jawed vise. Pull the axle shaft oil seal and bearing cup from the retainer with a Slide Hammer and Puller 943. The complete axle shaft assembly is shown in Figure 5.
9. Clean all parts thoroughly and install a new bearing cup in the retainer. Use a 3⅝″ O.D. sleeve and press.
10. Press or drive a new oil seal, lip inward, into the retainer using Step Plate 630-17.

    NOTE: *If necessary, replace the brake backing plate at this time. This is also the time to replace damaged wheel bolts.*
11. Lubricate the oil seal and install the brake assembly and bearing retainer on the axle shaft.
12. Use a 2¼″ I.D. x 30″ pipe and drive the bearing into position on the axle shaft. Lubricate the bearing with at least 3 oz. of wheel bearing grease.

    IMPORTANT: *Make certain the bearing is seated before installing the bearing retaining collar.*
13. Heat the retaining collar evenly around its circumference with a welding torch, until the collar turns black red. Quickly transfer the collar on the axle shaft. Position the pipe over the axle shaft and hold on the retaining collar until it seats.

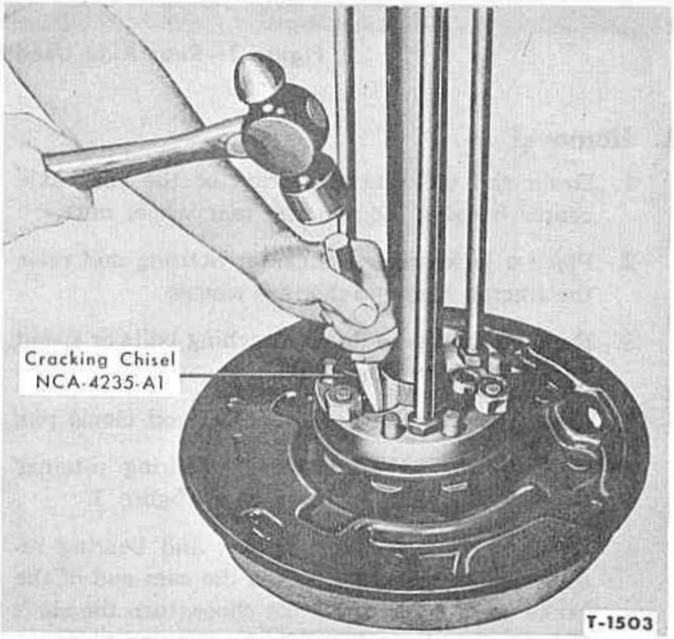


Figure 3—Cracking Chisel in Position to Split Bearing Retaining Collar

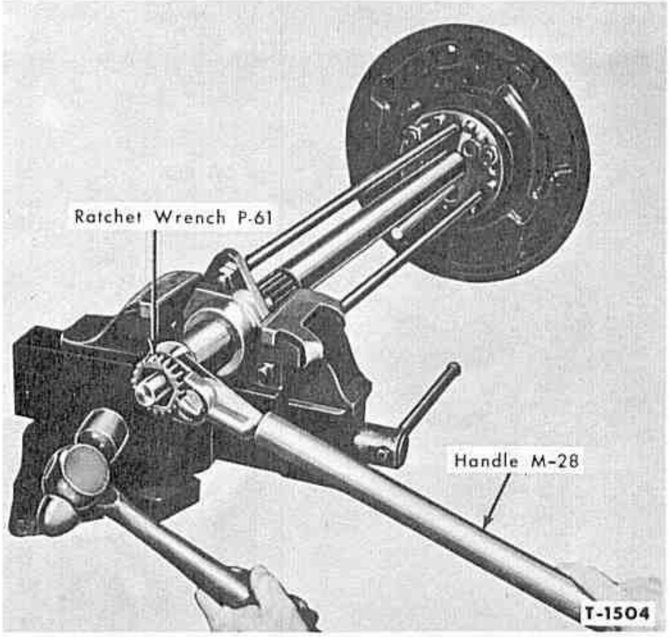


Figure 4—Pushing Axle Shaft Out of Bearing

C. Installation

1. Install the shim pack on the bearing retainer, Figure 6.
2. Install the rear axle assembly and insert the brake camshaft as the retainer engages the axle housing.
3. Turn the brake camshaft 90° to position the cam in the brake shoes, then seat the retainer against the housing.
4. Install the bearing retainer lock washers and nuts. Torque the nuts to 130-150 ft. lbs. Position the spring loaded cover over the brake camshaft hole.
5. Refer to "Axle Shaft End Play Adjustment" and adjust the end play before installing the brake drum.

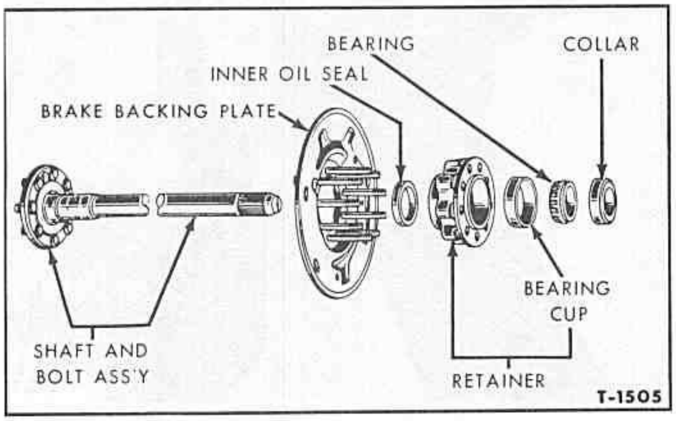


Figure 5—Axle Shaft Assembly

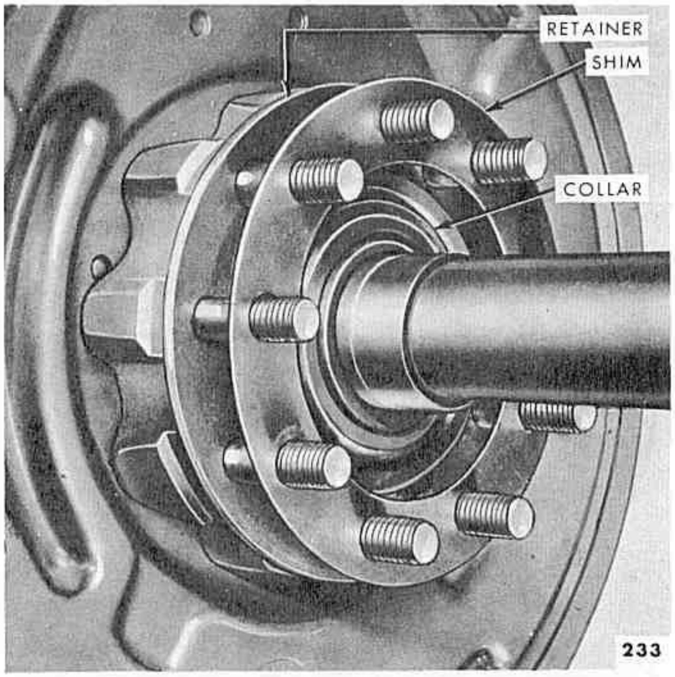


Figure 6—Axle Housing to Retainer Shims

D. Axle Shaft End Play Adjustment

1. Remove the wheel and brake drum.
2. Pull out and push in on the axle shaft flange to make certain that end play exists. If there is no noticeable end play, the axle shaft assembly must be removed from the housing and a shim added, Figure 6.
3. Install a dial indicator as shown in Figure 7.
4. Push in on the axle shaft and set the dial indicator at "zero." Pull out on the shaft and note the end play. Correct end play is 0.002-0.016".
5. Remove shims to decrease, or add shims to increase end play. Torque the retainer nuts to 130-150 ft. lbs.

AXLE HOUSING

A. Removal

1. Drain the lubricant from the center housing and remove the axle shaft, brake and retainer assembly as explained under "Rear Axle Shaft."

Left Axle: Remove the electrical wiring from the axle housing.

Right Axle: Remove the bolt securing the tool box to the axle housing.

2. Remove the fender and the lower lift link.
3. Support the axle housing and remove the retaining nuts. Save the parking brake pawl, clips, and brackets, but discard the gasket.

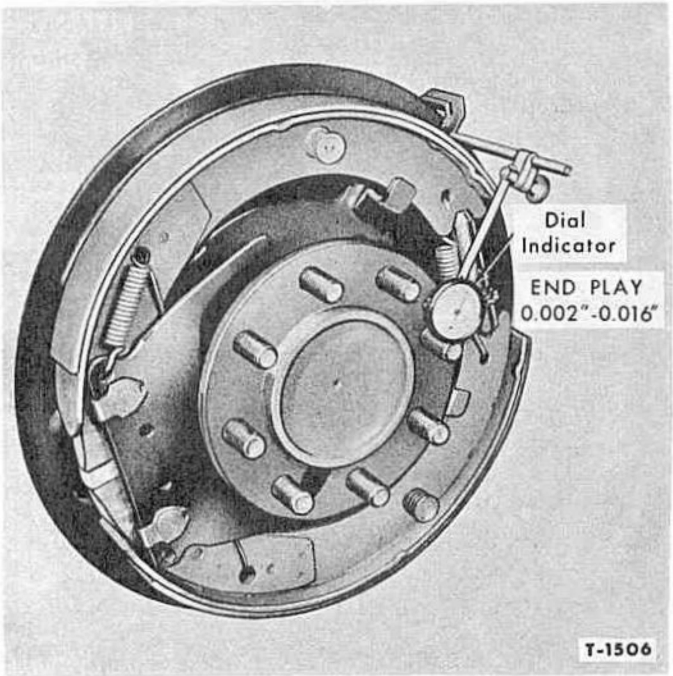


Figure 7—Checking Rear Axle Shaft End Play

B. Inspection

1. Inspect the housing for cracks and damage.
2. Inspect the bearing cup for discoloration and damage from overheating or scoring.
3. Inspect the thrust block in the left axle housing for wear or damage. If necessary, install a new block and torque the bolts to 25-30 ft. lbs. NOTE: ***The thrust block is located in the right axle housing on "Row Crop" tractors.***
4. Inspect the expansion plug in the brake camshaft hole for evidence of leaking. If necessary, drive the plug out toward the center housing and then install a new one.
5. Inspect the bushing in the brake camshaft hole for excessive wear. If necessary, collapse or split the bushing using a suitable chisel and then install a new bushing with Bushing Driver set 818.

C. Bearing Cap and Oil Seal Replacement

1. Remove the bearing cup with Puller 943 and a slide hammer.
2. Install a new cup with a brass drift and hammer. Make sure the cup is seated in the housing.
3. Remove the oil seal with Puller 956-2 and a slide hammer, Figure 8.
4. Drive in a new oil seal, lip inward, using Step Plate 630-12, Figure 9. Coat the contact surface of the seal with a small amount of Lubriplate or equivalent.
5. Remove the cotter pin, nut, and washer from the lower link support shaft. Remove the shaft by driving it out toward the brake drum.

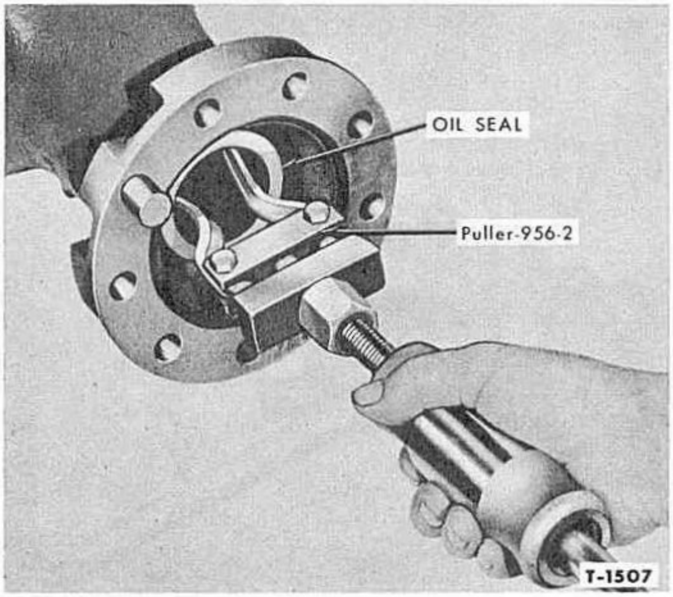


Figure 8—Removing Rear Axle Housing Oil Seal

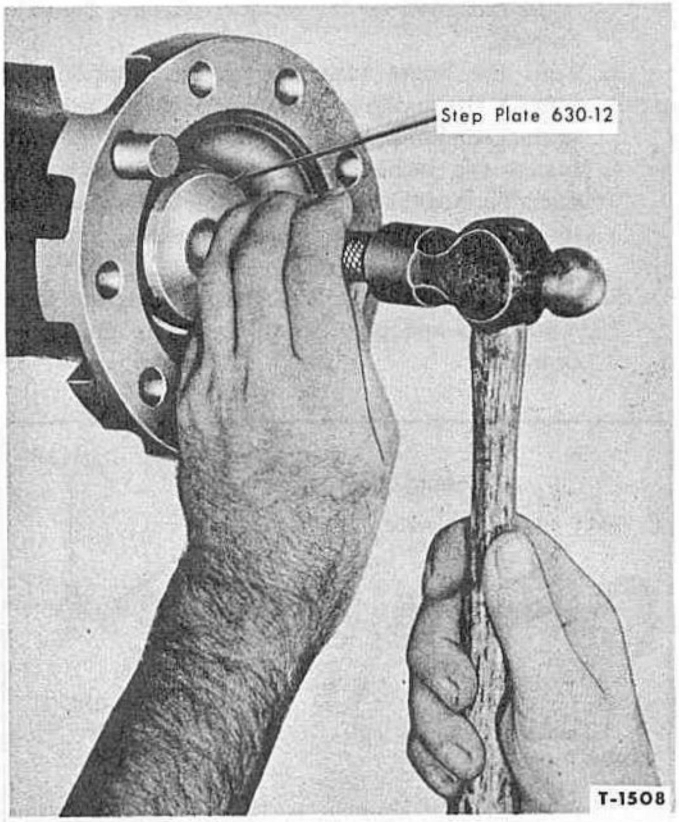


Figure 9—Installing Rear Axle Housing Oil Seal

6. Insert the new lower link tapered shaft and seat it with a soft-head hammer. Install the washer and nut. Tighten the nut and rap the shaft again to insure 100% fit. Torque the nut to 150 ft. lbs. and install the cotter pin.

D. Installation

1. Clean the mating surfaces of the axle housing and center housing.
2. Position a new gasket on the center housing studs and install the housing. Position the parking brake pawl, and linch pin holder, then install the retaining nuts. Torque the nuts to 55-65 ft. lbs. (on tractors after Serial No. 106387, torque the nuts to 65-70 ft. lbs. On Series 1801 and Series 801 Tractors equipped with 9/16" nuts, torque the nuts to 130-150 ft. lbs.).

Left Axle: Install the exhaust bracket, wiring clip, and lamp socket.

Right Axle: Bolt the tool box to the axle housing.

3. Install the axle shaft assembly and fender. Connect the taillamp wiring and install the lower lift link.

Row Crop Tractors: Install a new "O" ring on the axle housing, then install the final drive and fender.

DIFFERENTIAL OVERHAUL

A. Removal

1. Remove the left wheel, then the axle shaft and housing assembly.

Row Crop Tractors: Remove the right wheel, final drive assembly and axle housing.

2. Lift the differential out of the housing and mount it in a soft-jawed vise.

B. Disassembly

1. If the differential case halves are not marked, make a chisel mark across the mating surfaces, so that later they can be joined in the same position.

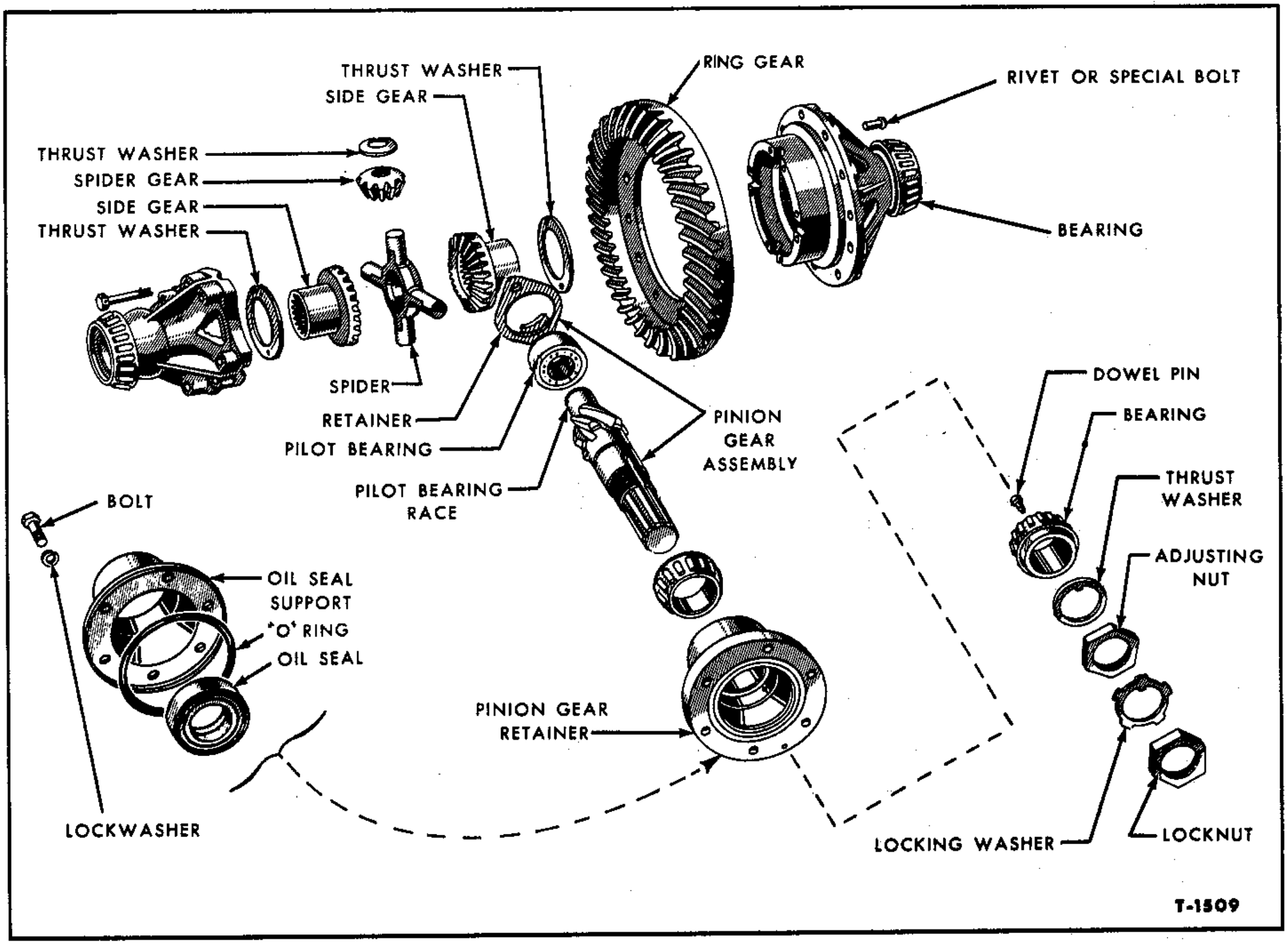


Figure 10—Differential & Pinion Gear Assemblies

2. Remove the differential bolts and separate the case halves using a soft hammer.

   NOTE: ***If the bolts are provided with lock wire, remove it, then remove the bolts.***
3. Remove the spider, small thrust washers, spider gears, side gears and large thrust washers, Figure 10.

C. Inspection

Clean all the parts thoroughly in solvent before inspecting.

1. Inspect all the gears for cracks and worn or chipped teeth.
2. Inspect the thrust washers, and their support facings for wear or score marks.
3. Inspect the bearings for signs of overheating, chipped, missing, or worn rollers.

D. Bearing Replacement

1. Remove the bearing using Puller 1003 and Step Plate 630-10.
2. Clean the bearing seat and press on new bearings using Plate 501.

E. Ring Gear Replacement

1. Drill through the rivet heads, Figure 11, using a 7/16" drill. Press out the rivets and remove the ring gear.

   NOTE: ***Drilling the rivet completely out may enlarge the hole.***
2. Remove all dirt, chips, or burrs, from the mating surfaces. Position the ring gear on the case and install special rivets or bolts. If bolts are used, torque the nuts to 90-110 ft. lbs. and install the cotter pins. If rivets are used, the ends must be upset with a suitable press and must not extend more than 0.06" above the surface.

   NOTE: ***On Series 801 and 1801 Tractors, the rivet heads are installed on the differential housing side; on all other series, the heads are installed on the gear side.***

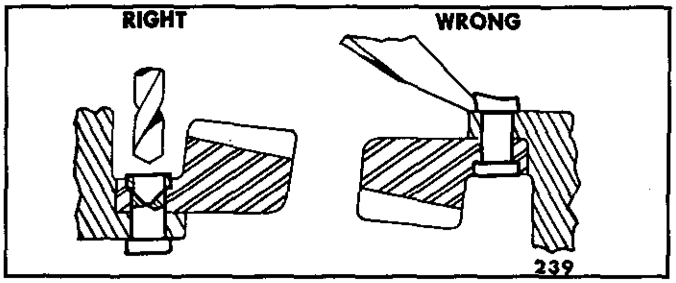


Figure 11—Removing Ring Gear Rivets

F. Assembly

Coat the thrust face of the side gears and the surface of the spider with Lubriplate before assembly.

1. Stand the ring gear side of the case half on end.
2. Install the differential side gear thrust washers and side gears, Figure 10.
3. Place the spider gears and small thrust washers on the spider and position the spider in the ring gear side of the case half.
4. Mate the numerals on the case halves (or the marks placed on the case at disassembly) and join the case halves.
5. Install the differential case bolts and torque them to 90-100 ft. lbs. Install the lock wire if so equipped.
6. Place the differential in the housing and install the housing, shaft, and brake assembly.

PINION OVERHAUL

A. Removal

To work on the pinion gear assembly, the center housing must be separated from the transmission and the drive coupling removed. See page 168 and use the necessary procedures.

Effective in tractor production at Serial No. 54166, all four-speed transmission tractors incorporated a drive line spline change. The previous drive line parts have ten straight side splines while the new parts have twenty-three involute splines. There is no interchangeability between the old and new parts.

Series 600 and 601 Tractors are equipped with the pinion rear or "pilot" bearing pressed and staked to

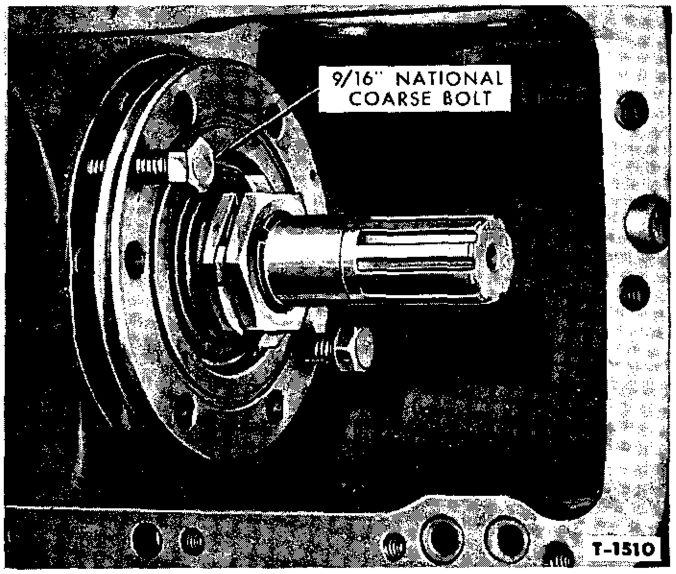


Figure 12—Removing Pinion Gear Retainer and Shaft Assembly

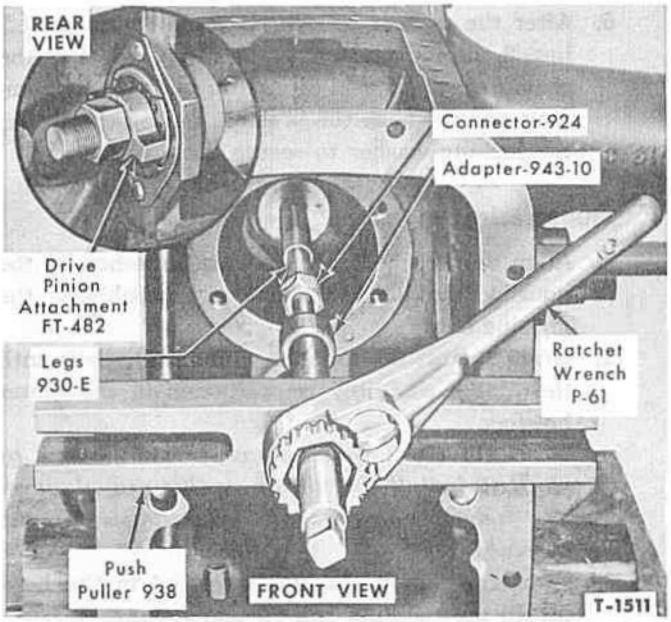


Figure 13—Removing Pinion Gear Pilot Bearing

the pinion shaft. In this case, the axle housing and differential assembly must also be removed to provide clearance to remove the pinion assembly.

1. Remove the pinion gear retainer bolt and the oil seal support, Figure 10.
2. Insert two $\frac{9}{16}$" x 3" National Coarse bolts in the retainer and use them as "pullers", Figure 12. Remove the retainer and pinion assembly.

B. Disassembly

1. Clamp the pinion gear retainer in a soft-jawed vise.
2. Straighten the lips of the locking washer and remove the lock nut, locking washer, adjusting nut, and thrust washer, Figure 10.

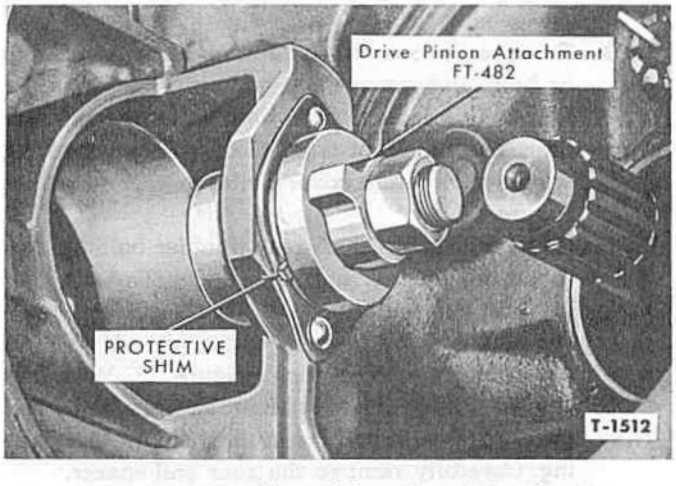


Figure 14—Installing Pinion Gear Pilot Bearing

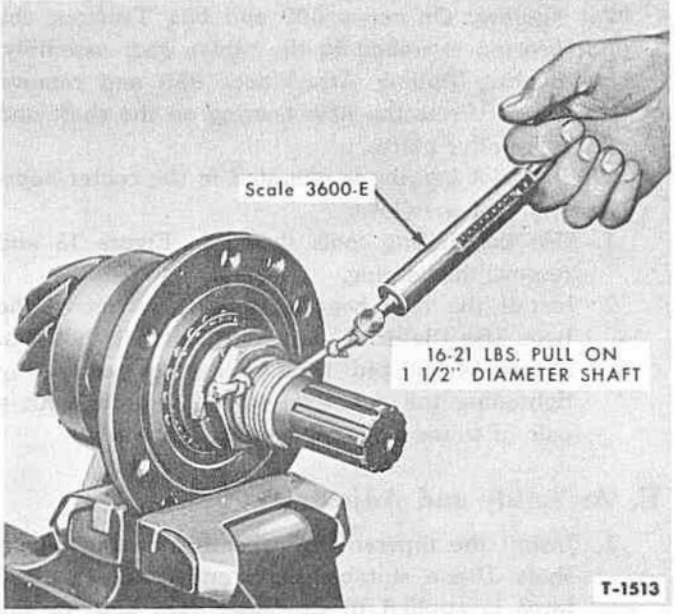


Figure 15—Checking Pinion Gear Bearing Preload

3. Use Bearing Puller Attachment 951 behind the rear bearing and press the bearings and retainer assembly off the gear.

C. Inspection

1. Clean all parts and inspect the pinion gear for wear, cracks, or chipped teeth.
2. Inspect the bearings for signs of overheating, chipped, missing, or worn rollers.
3. Inspect the bearing cups for scoring.
4. Inspect the rear or "pilot" bearing race for looseness or scoring, Figure 10. Look inside the differential housing and inspect the bearing and retainer.

Series 600 and 601 Tractors: The pilot bearing remains with the pinion gear assembly, so instead of inspecting just the bearing race, inspect the entire bearing.

D. Overhaul

1. Clamp the pinion gear retainer, Figure 10, in a soft-jawed vise and remove the cups with Puller and Slide Hammer 943.
2. Install new cups with Step Plate 630-17, Adapter 973-FT-1A and a press.
3. Remove the oil seal from the oil seal support, Figure 10. Press in the new seal using Step Plate 630-7.
4. Split the pilot bearing race with a chisel and remove it from the pinion gear. File the high spots on the pinion shaft and press on a new race. Use a hammer and punch and "stake" the race to the shaft.

Pilot Bearing: On series 600 and 601 Tractors, the pilot bearing is staked to the pinion gear assembly. Use Bearing Pulling Attachment 950 and remove the bearing. Press the new bearing on the shaft and "stake" it in five places.

If the pilot bearing is mounted in the center housing, remove it as follows:

1. Use the pulling tools shown in Figure 13 and remove the bearing.
2. Install the new bearing from the front of the bore. Use the drive pinion attachment shown in Figure 14 and pull the bearing into position by tightening the nut. Protect the retainer with a pair of shims positioned under the washer.

E. Assembly and Adjustment

1. Install the tapered inner bearing on the pinion shaft. Use a suitable press and make sure the force is applied to the inner race only or the bearing may be damaged.
2. Install the pinion shaft and bearing in the retainer.
3. Install the pinion shaft outer (front) bearing using a 1¾" I.D. sleeve and press.
4. Install the thrust washer and the adjusting nut.
5. Turn the adjusting nut in a clockwise direction to increase the preload on the bearing. Correct bearing preload with new bearings is 16 to 21 lbs. pull when checked with a pull scale as shown in Figure 15. With used bearings the pull should be 8-10 lbs.
6. After the correct bearing preload is established, install the locking washer and lock nut. Tap the pinion shaft in both directions with a soft hammer, and re-check the preload. Bend two tabs on the locking washer to secure both nuts.

F. Installation

1. Align the retainer dowel pin with the hole in the housing, and place the pinion assembly in the housing bore.
2. Drive against the retainer with a brass drift until the pinion assembly is positioned in the center housing.
   IMPORTANT: ***Never hammer on the end of shaft to install the pinion as this may damage the bearings, cups, or other parts of the assembly.***
3. After the pinion retainer is seated in the bore, install the "O" ring and oil seal support.
4. Install the bolts and lock washers. Torque the bolts to 80-100 ft. lbs.
5. Refer to "Center Housing Replacement" and attach the center housing to the transmission.
6. Be sure the differential assembly and the internal section of the housing is clean. Place the differential in the housing, being careful not to damage the mating splines.
7. Install the axle shaft housing, axle shaft and brake assembly, as detailed on page 261.
8. Fill the rear axle and center housing to the correct level with the specified lubricant.

2. ROW CROP TRACTORS

The rear axle assembly on "Row Crop" tractors features a final drive assembly located at the end of the axle housing. A sectional view of the final drive and axle assembly is shown in Figure 16.

The differential assembly is removed from the right side of the center housing instead of the left as in "General Purpose" tractors. The differential, axle housing, and pinion service is covered in Section 1, "General Purpose and Industrial Tractors".

FINAL DRIVE

The following information provides the necessary steps to overhaul the right or left final drive assembly.

A. Removal

1. Loosen the rear wheel nuts.
2. Raise the rear axle and support the side being removed.
3. Remove the rear wheel. Remove the speed nuts or bolts and remove the brake drum.
4. Remove the plug from the bottom cover and drain the lubricant from the final drive housing. Remove 8 bottom cover bolts, cover, and gasket, Figure 17.
5. Remove 6 lower shaft rear retainer bolts and remove the retainer and shim pack. Tag the shim pack for reassembly.
6. Remove the lower shaft cotter pin, slotted nut, flat washers, and bearing, Figure 17. Withdraw the lower shaft while holding the large final drive gear to prevent it from falling out of the housing. Carefully remove the gear and spacer.
7. Remove the brake assembly.

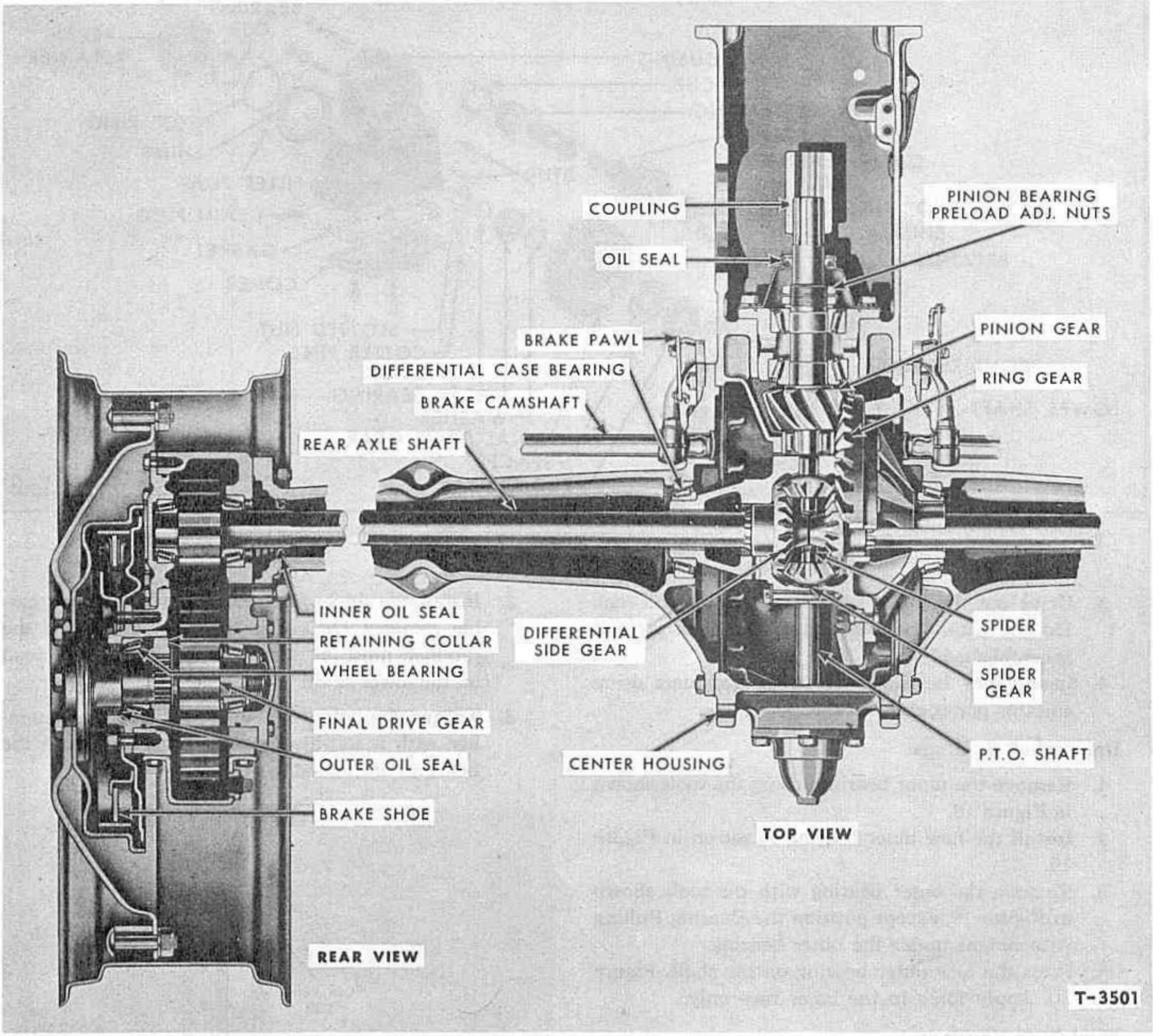


Figure 16—Sectional View of Row Crop Rear Axle and Final Drive

8. Remove the lower shaft front bearing retainer, Figure 17.
9. Remove the upper shaft bearing retainer assembly and the upper shaft. Tag the shim pack for reassembly.
10. Remove the final drive housing.
11. Remove the oil filler plug and drain plugs, if replacing the housing, and install them in the new housing.

B. Inspection

1. Inspect all bearings and cups for evidence of over-heating, chipping, or scoring.
2. Inspect the housing for cracks or damage.
3. Inspect the housing studs for damaged threads.
4. Check the final drive gear for chipped or worn teeth.

C. Repair of Sub-Assemblies

Bearing Cups:

1. Remove the bearing cup from the upper shaft retainer, using Bearing Cup Puller 943 and a slide hammer.
2. Remove the bearing cups from the lower shaft retainers, using the tools mentioned in step 1.

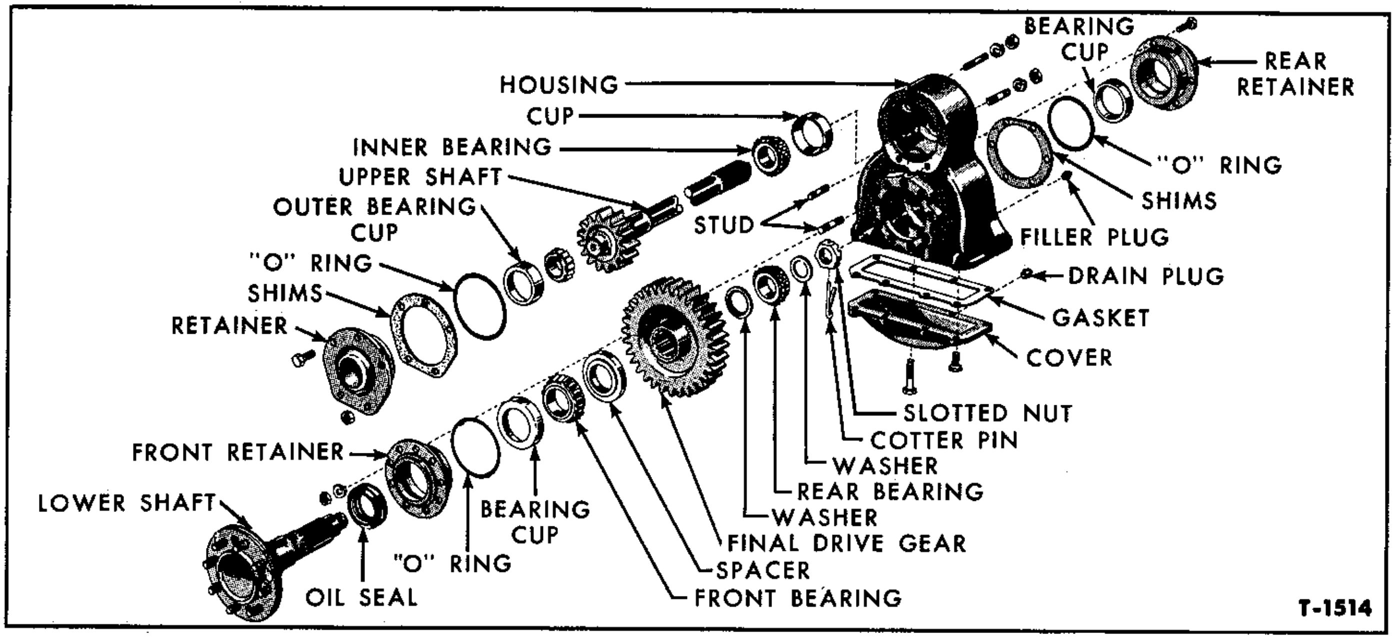


Figure 17—Final Drive Assembly

3. Drive out the lower shaft front retainer oil seal. Do not install the new seal until correct preload is established.
4. Install new bearing cups in the retainers using suitable plates and a press.

Upper Shaft Bearings:

1. Remove the inner bearings using the tools shown in Figure 18.
2. Install the new inner bearing as shown in Figure 19.
3. Remove the outer bearing with the tools shown in Figure 19, except position the Bearing Pulling Attachment under the outer bearing.
4. Press the new outer bearing on the shaft, Figure 20. Apply force to the inner race only.

Final Drive Housing:

1. Use a punch and hammer and drive the upper shaft inner bearing cup from the housing.
2. Install the new cup using a brass drift and hammer or a suitable plate and press.
3. Replace damaged studs. Torque the new studs to 40-45 ft. lbs.

D. Preload

The rear axle shaft bearing preload must be established before installing the rear axle shaft or final drive housing on the rear axle housing. Preload on both the axle shaft and final drive shaft must be set independently.

1. Clamp the final drive housing in a soft-jawed vise and insert the upper axle shaft.
2. Install the upper shaft shim pack and the bearing retainer. Do not install the "O" ring as the retainer must be removed to establish preload on the lower shaft.
3. Torque the bolts to 60-70 ft. lbs. Rap the assembly with a soft-head hammer to make sure the bearings are seated.

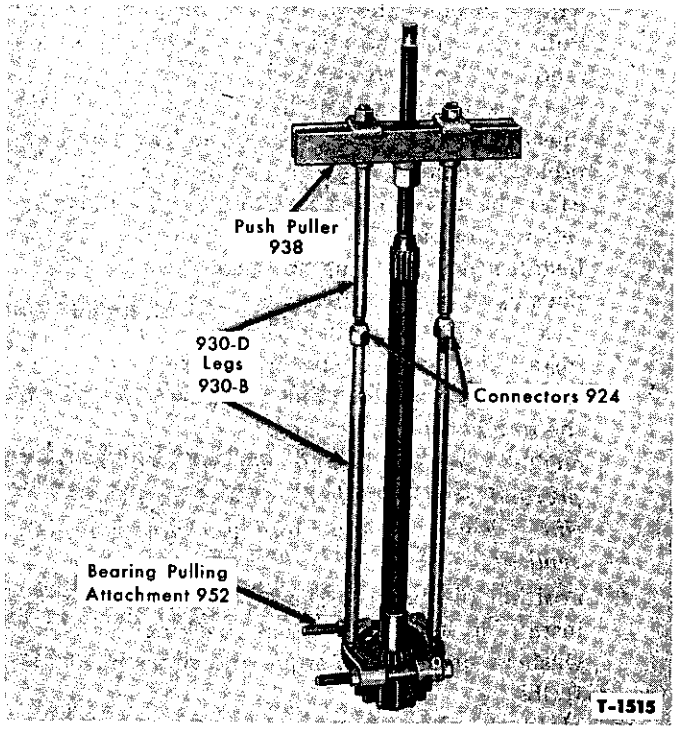


Figure 18—Removing Upper Shaft Inner Bearing

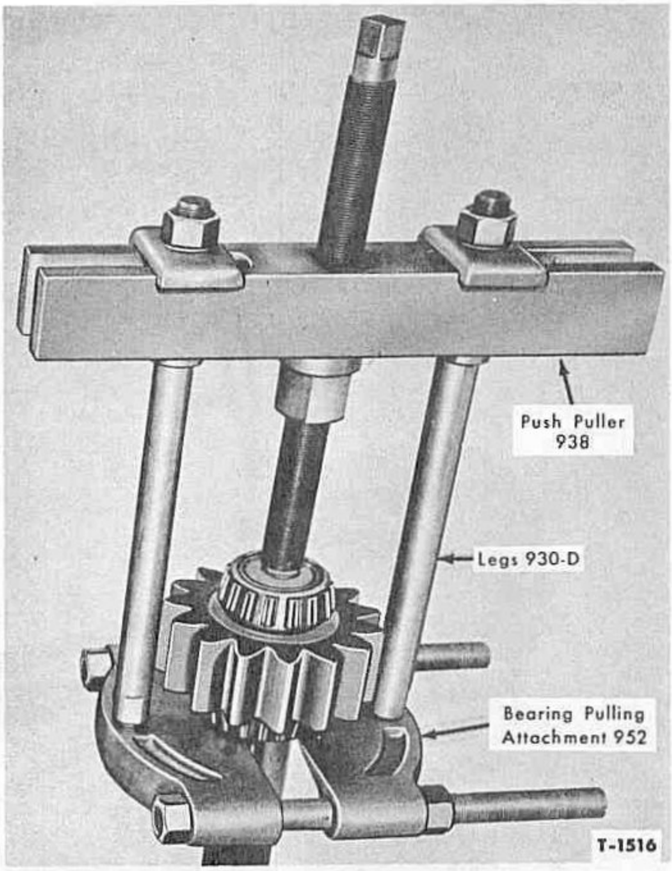


Figure 19—Installing Upper Shaft Inner Bearing

4. Attach a small cord to Pull Scale 3600-E and wrap it around the shaft as shown in Figure 21.
5. Pull, and with the shaft turning, note the scale reading. The correct preload is 7-21 lbs. if new bearings are used, or 6-18 lbs. when the old bearings are used. If necessary, add shims to decrease preload, remove shims to increase preload.
6. After the top preload is established, remove the retainer and axle shaft. Keep the shims intact.
7. Install a new "O" ring and attach the final drive housing to the axle housing. Torque the nuts (no lock washers) to 160-175 ft. lbs.
8. Install the bearing, spacer, and "O" ring in the lower shaft front retainer, Figure 17. Position the retainer in the housing.

   NOTE: ***Do not install the oil seal until the preload is established. The drag of the seal can cause a variable and inaccurate preload reading.***
9. Position the brake assembly over the studs and install at least four brake backing plate lock washers and nuts. Torque the nuts to 130-150 ft. lbs.
10. Hold the final drive gear in the housing and insert the lower shaft. Secure the shaft with the washer, rear bearing, smaller washer, and slotted nut.
11. Install the shim pack and the rear retainer without the "O" ring. Torque the retainer bolts to 60-70 ft. lbs.

    NOTE: ***If the tractor is equipped with an implement drive shaft adapter, wait until preload is established before installing the drive shaft oil seal.***
12. Wrap a piece of twine around the outside of the wheel studs and attach Pull Scale 3600-E.
13. Pull, and with the shaft turning, note the scale reading. The correct preload is 2-5 pounds. If necessary, remove shims to increase preload, or add shims to decrease preload.
14. After the correct preload is established, remove the lower shaft.

E. Installation

Always use new oil seals and "O" rings. Use a short fiber grease and lubricate all bearings, oil seals, and "O" rings as the final drive is assembled.

1. Install the oil seal in the lower shaft front retainer. Make sure the seal is flush with the machined surface of the retainer.
2. Install the upper shaft, retainer, "O" ring, and established shim pack. Torque the nuts and bolts to 60-70 ft. lbs.
3. Install the brake assembly. Position the brake

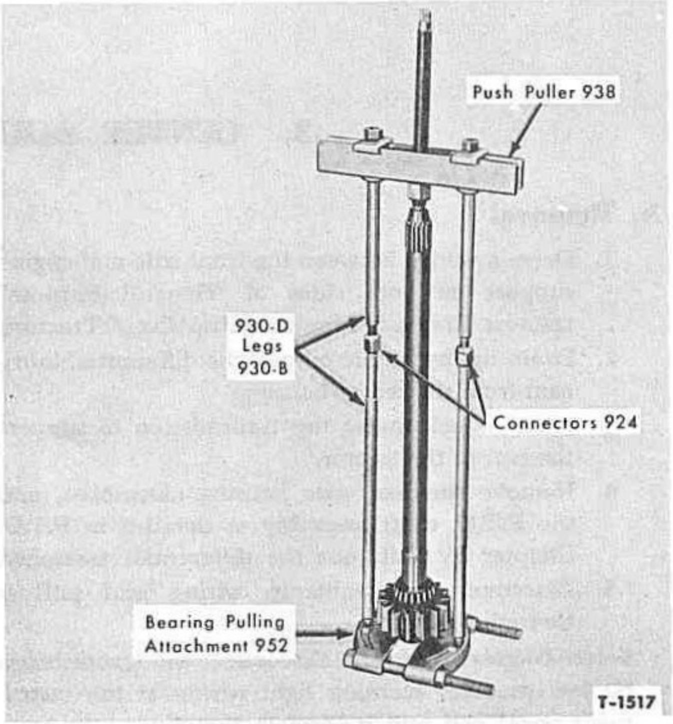


Figure 20—Installing Upper Shaft Outer Bearing

backing plate so the brake camshaft can be installed. Torque the nuts to 130-150 ft. lbs.

4. Install the lower shaft front bearing and spacer in the front retainer. Position the final drive gear in the housing, and install the lower shaft.
5. Install the rear bearing, flat washers, and nut. Torque the nut to 200 ft. lbs. minimum and install the cotter pin. On tractors equipped with an implement drive, install the pin and retaining ring.
6. Install the established shim pack and a new "O" ring on the lower shaft rear retainer. Bolt the retainer on the final drive housing and torque the bolts to 60-70 ft. lbs. On tractors equipped with an implement drive, install the oil seal in the retainer.
7. Install a new gasket and the cover on the housing. Torque the bolts to 20-25 ft. lbs.
8. Install the brake drum and speed nuts or bolts.
9. Install the drain plug and add 1.5 quarts of new final drive lubricant through the filler plug hole in each housing, Figure 17. Install the filler plug.
10. Install the rear wheel and remove the support equipment.

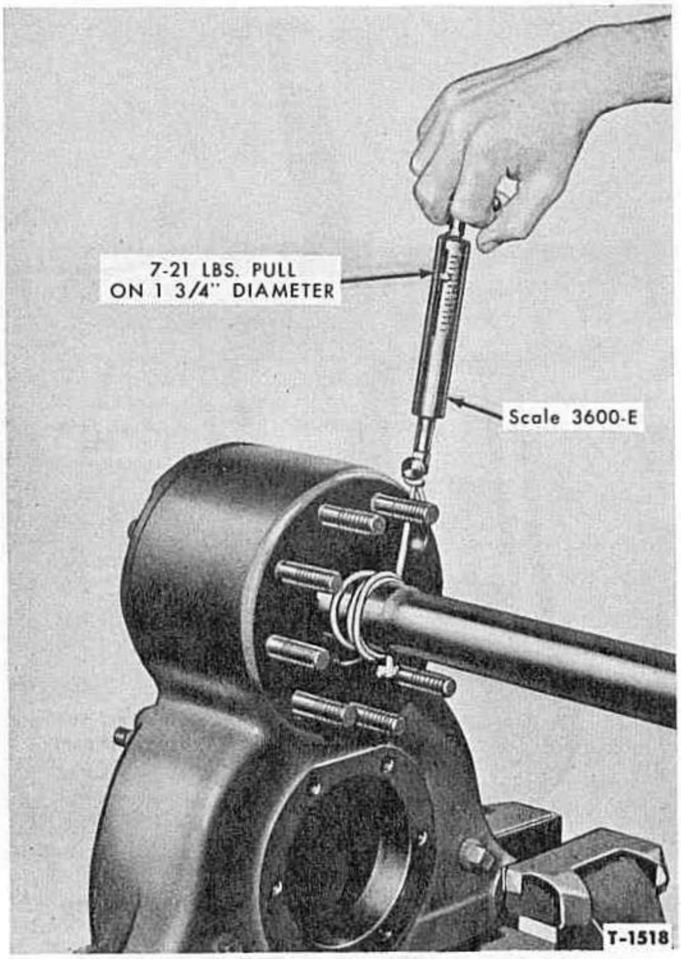


Figure 21—Checking Upper Shaft Preload

3. CENTER HOUSING REPLACEMENT

A. Removal

1. Drive a wedge between the front axle and engine support on both sides of "General Purpose" tractors. Cradle the front of "Row Crop" Tractors.
2. Drain the hydraulic oil and the differential lubricant from the center housing.
3. Place a jack under the transmission to support the rear of the tractor.
4. Remove the rear axle housing assemblies, and the P.T.O. shaft assembly as detailed in P.T.O. Chapter IV. Lift out the differential assembly.
5. Disconnect the taillamp wiring and pull it through the clips.

Select-O-Speed Tractors: Disconnect the transmission oil low pressure warning light wiring at the instrument panel and pull it through the clips.

6. Remove the P.T.O. shifter plate or traction clutch shifter plate on Select-O-Speed Tractors, from the left side of the center housing.
7. If the brake cross shaft is located through the bottom of the center housing, disconnect the brake rods, then remove the right lever and pull the cross shaft out.
8. Disconnect the hydraulic lift rocker from the draft control spring and center housing, then remove the rocker.
9. Remove the tractor seat, the brake lock control rod brackets, and the hydraulic lift cover.
10. Remove the right and left step plate to center housing bolts.
11. Place a sling around the center housing and support the weight with a hoist.
12. Position a pan under the center housing to catch the excess oil and disconnect the housing from the transmission case.

B. Replacement

1. Remove the draw bar clevis assembly and the drawbar hanger then attach them to the new housing.
2. Remove the hydraulic lift sump cover plate from the bottom of the center housing. Remove the relief valve as shown in Part FOUR, Chapter II, Section 6.
3. Place new "O" rings on the relief valve and push it into the bore. Position a new gasket and "O" ring on the plate and install the plate on the new center housing. Torque the bolts to 35-45 ft. lbs.
4. Install the pinion gear assembly in the new housing. Torque the retainer bolts to 80-100 ft. lbs.
5. Install new studs in the new center housing and torque them to 40-45 ft. lbs.
6. Rivet a new pinion pilot bearing retainer in the center housing, then install the bearing.

Series 600 Tractors: The pilot bearing is staked to the pinion assembly so the center housing does not have a pinion retainer.

7. Position a new P.T.O. oil seal in the center housing (letters forward).

C. Installation

1. Support the new center housing with a hoist. Place a new gasket and "O" rings on the mating surface. Position the drive coupling (also P.T.O. coupling on Select-O-Speed Tractors) then join the center housing to the transmission. Install the bolts and nuts and torque them to 40-50 ft. lbs.
2. Position new gaskets on the center housing to axle housing mounting studs.
3. On "General Purpose" tractors, install the right axle housing assembly, complete with the fender.

   On "Row Crop" tractors, install the left axle housing assembly complete with fender and final drive assembly. Next, install the differential carrier assembly in the center housing and then install the opposite axle housing assembly.

   NOTE: ***Make sure the parking brake pawl, clips, etc., are properly positioned on the axle housing.***
4. Install the wheels and remove the supports.
5. Clean the mating surfaces of the hydraulic lift cover assembly and the center housing.
6. Install two new "O" rings in the center housing and position the lift cover gasket on the center housing. Install the hydraulic lift cover assembly and the brake lock control rod brackets.
7. Install the rocker assembly on the center housing and connect the draft control spring yoke to the rocker.
8. Connect the lift rods to the hydraulic lift arms and connect the lift link check chains to the draw bar hanger.
9. Install the brake cross shaft and lever. Connect the brake rods.
10. Install the P.T.O. assembly.
11. Use a new gasket and install the P.T.O. shifter plate, or Select-O-Speed traction clutch shifter plate on the center housing. Torque the bolts to 40-55 ft. lbs.
12. Install the left step plate and connect the clutch rod.
13. Install the right step plate and tool box.
14. Connect the taillamp and Select-O-Speed oil pressure warning wiring.
15. Install the drain plugs and fill the differential and hydraulic system to the proper level with the correct grade of lubricant.
16. Start the engine and check the hydraulic system for leaks.

4. SPECIFICATIONS

Preload and End Play

Description	General Purpose	Row Crop	Cord Location
Pinion with			
new bearings	16-21 lbs.	16-21 lbs.	Pinion shaft
used bearings	8-10 lbs.	8-10 lbs.	Pinion shaft
Final drive			
upper shaft	—	7-21 lbs.*	Ground part of shaft
lower shaft	—	2-5 lbs.*	Wheel Bolt Circle
Axle Shaft end play	0.002″-0.016″	—	—
*Use small figures for used ("broken in") assemblies			

Nut and Bolt Torques—Ft. Lbs.

Description	General Purpose	Row Crop
Axle Shaft retainer or final drive nuts	130-150	160-175
Thrust block bolts	25-30	25-30
Lower link shaft nut (inside)	150	150
Axle to center housing studs	40-45	40-45
Axle to center housing nuts	55-65	55-65
After Serial #106387	65-70	65-70
Equipped with 9/16″ nuts	130-150	—
Drive gear bolts	90-110	90-110
Differential case (both type bolts)	90-100	90-100
Pinion retainer bolts	80-100	80-100
Final drive housing studs	—	40-45
Upper shaft retainer bolts	—	60-70
Brake backing plate nuts	—	130-150
Lower shaft rear retainer bolts	—	60-70
Lower shaft rear bearing nut	—	200
Bottom cover bolts	—	20-25
Relief valve plate bolts	35-45	35-45
Center housing to transmission (nuts & bolts)	40-50	40-50
P.T.O. Shifter plate, or Select-O-Speed traction coupler plate	40-55	40-55

5. SPECIAL TOOLS

Most of the special tools listed below are illustrated in the preceding Sections of this chapter. These tools are required to properly service the rear axle.

Tool No.	Description
943-10	Adapter
973-F-1A	Adapter
943	Bearing Cup Pulling Attachment
950	Bearing Pulling Attachment
951	Bearing Pulling Attachment
952	Bearing Pulling Attachment
NCA-4235	Collar Cracking Puller
NCA-4235-A1	Collar Cracking Chisel
924	Connector

Tool Number	Description
FT-482	Drive Pinion Attachment
956-2	Pilot Bearing Puller
3600-E	Pull Scale
938	Push Puller
930-B	Push Puller Legs
930-D	Push Puller Legs
930-E	Push Puller Legs
P-61	Ratchet
630-7	Step Plate
630-12	Step Plate
630-17	Step Plate
▲ ▲	Dial Indicator
▲ ▲	Torque Wrench

Part TWO

CLUTCH, TRANSMISSIONS, REAR AXLE AND POWER TAKE-OFF

Chapter

IV

Power Take-Off

Section Page
1. Power Take-Off 273
2. Power Take-Off Conversion Assembly 277
3. Belt Pulley 278
4. Specifications 281
5. Special Tools 281

1. POWER TAKE-OFF

SHAFTS

The following procedures on the P.T.O. shaft start with the shaft at the rear of the transmission, Figure 1. Procedures covering the P.T.O. shaft inside the transmission are presented in Chapter II.

A. Two Speed P.T.O. Overhaul—Select-O-Speed Transmissions

CAUTION Don't take unnecessary risks when working around the P.T.O. shaft. Avoid wearing loose fitting clothing and remain clear of moving parts.

1. Drain the fluid from the differential and hydraulic reservoir compartments of the center housing.
2. Remove the P.T.O. cap and the four bolts securing the cover, Figure 2.
3. Pull the cover and shaft assembly from the housing. Mount the shaft in a pipe vise.
4. Remove the socket head bolt, Figure 2, and pull the adapter from the sleeve.
5. Press the sleeve and cover off the P.T.O. shaft.
6. Remove the outer snap ring and tap the sleeve and bearing out of the cover.
7. Use Step Plate 630-9 and press the oil seal out of the cover. Install a new seal with the lip facing the center housing.
8. Inspect the sleeve and bearing. If necessary, remove the inner snap ring, Figure 2, from the sleeve, then press the sleeve out of the bearing. Press a new bearing on the sleeve and install the inner snap ring.
9. Inspect the P.T.O. shaft for cracks or damaged splines. Lubricate a new "O" ring, Figure 2, and install it on the shaft.
10. Slide the outer snap ring on the P.T.O. shaft, lubricate the shaft splines and install the sleeve on the P.T.O. shaft.
11. Coat the oil seal with grease and install the cover on the sleeve. Tap the cover with a soft-head hammer to seat the bearing.
12. Install the outer snap ring and the adapter, Figure 2. Secure the adapter with the socket head bolt.
13. Remove the shifter plate (drive line disconnect plate on Select-O-Speed equipped tractors) from the left side of the center housing. Reach inside the center housing and feel the condition of the oil seal. If necessary, split the center housing from the transmission and install a new oil seal. Coat the new seal with grease and bolt the center housing to the transmission.

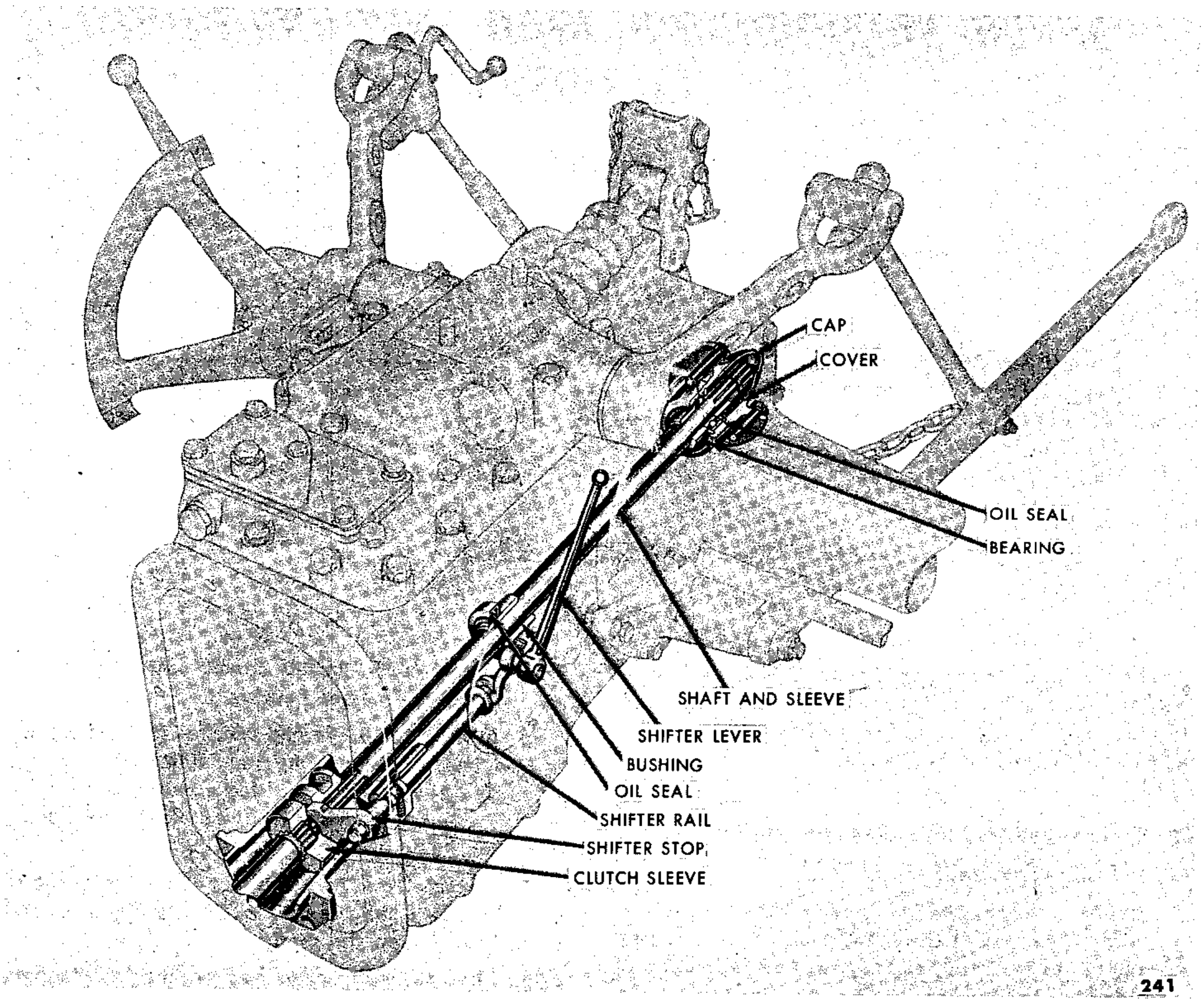


Figure 1—P.T.O. Shaft and Shifter Assembly—Four and Five Speed Transmissions

NOTE: ***On Select-O-Speed equipped Tractors, make sure the P.T.O. coupling is in position.***

14. Use a new gasket and install the shifter or drive line disconnect plate.

15. Use a new gasket and install the P.T.O. shaft assembly. Check for engagement with the forward splined coupling.

16. Install the cover bolts and torque them to 35-40 ft. lbs. Install the P.T.O. cap and fill the hydraulic and differential systems with the recommended lubricant.

B. Single Speed P.T.O. Overhaul

The overhaul procedure for all current production single speed P.T.O. shafts are similar for five speed, four speed, and Select-O-Speed transmissions.

A new Induction Hardened Power Take-Off Shaft, 312428, is available as a service replacement only for P.T.O. shaft 310091, where heavy duty P.T.O. operation is experienced. This part has been made available for use with specialized equipment that subjects the shaft to high impact loads. The new shaft can be identified by the letter "H" stamped on the outer end.

1. Drain the hydraulic and differential fluid from the center housing.

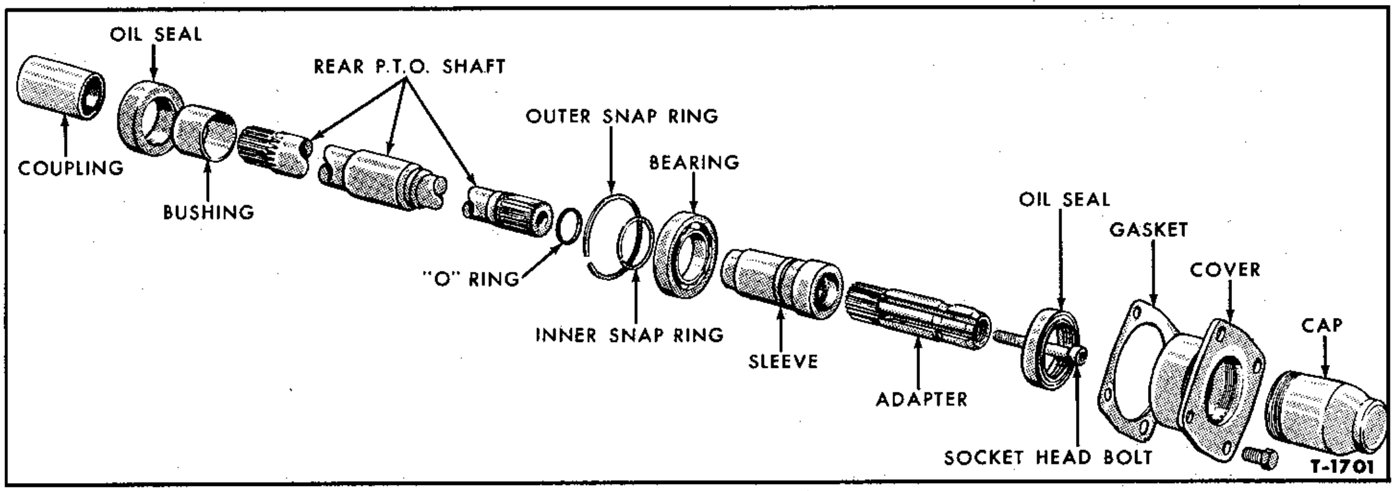


Figure 2—Two Speed P.T.O. Shaft

2. Remove the cap and four cover bolts, then remove the cover and shaft assembly.
3. Remove the outer snap ring, Figure 3, from the P.T.O. cover. Use Puller 1003 and pull the cover off the shaft.
4. Use Step Plate 630-9 and press the oil seal out toward the threaded end of the cover.
5. Use Bearing Puller Attachment 951 and press the sleeve and bearing, Figure 3, off the shaft.
6. Press a new bearing on the shaft with a 1½″ I.D. sleeve. Make sure the shaft snap ring, Figure 3, is installed on the 1⅜″ P.T.O. shaft.
7. Press the sleeve on the shaft until seated tight against the bearing.
8. Press a new oil seal in the cover (lip inward) using Step Plate 630-9. Position the seal 0.020″ to 0.060″ behind the bearing seat. On the 1⅛″ diameter shaft, seat the seal against the inner snap ring shown in the insert, Figure 3.
9. Coat the bearing and oil seal with a film of grease. Press the cover on the P.T.O. shaft and install the outer snap ring, Figure 3.
10. Use a new cover gasket and install the P.T.O. assembly in the center housing. Make sure the splines mesh.
11. Install the four cover bolts and torque them to 35-40 ft. lbs. Install the P.T.O. cap.

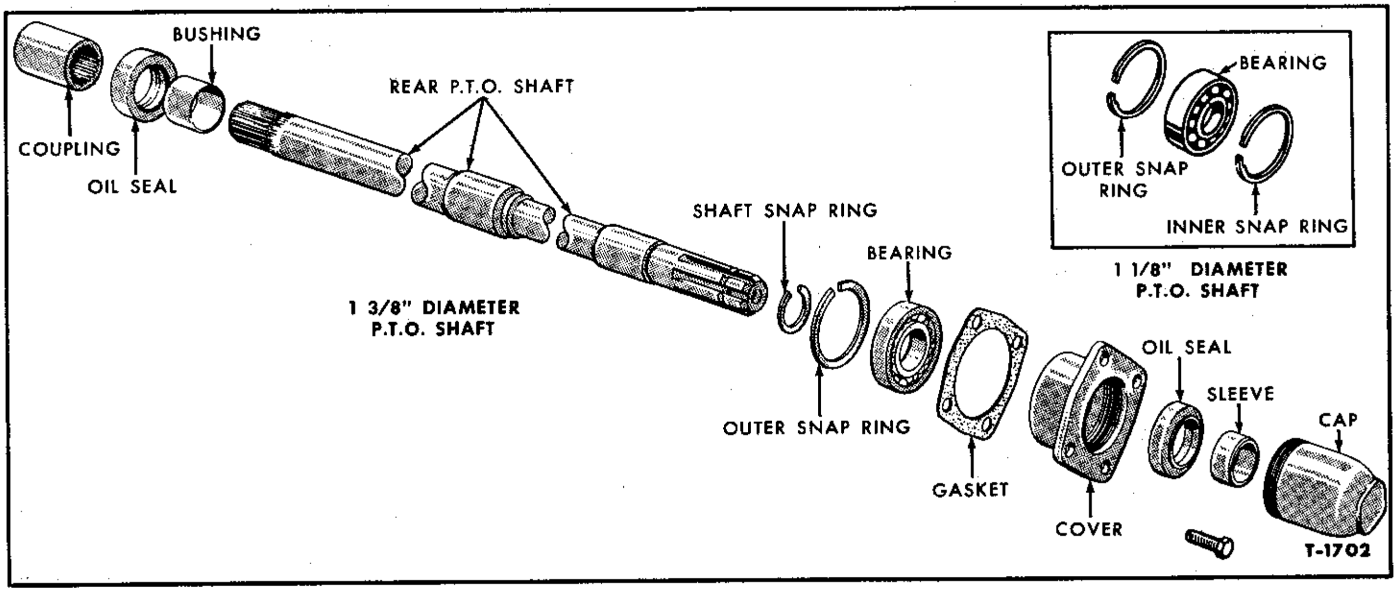


Figure 3—Single Speed P.T.O. Shaft

SHIFT LEVERS

A. Four and Five Speed Transmission P.T.O. Shift Lever Overhaul

1. Drain the front (hydraulic) section of the center housing.
2. Remove the shifter plate, Figure 4, and discard the gasket.
3. Remove damaged studs and install new ones. Torque the studs to 40-45 ft lbs.
4. Inspect the shifter fork, Figure 4. If worn or damaged, remove the rivet and tap the fork out of the lever.
5. Dip a new "O" ring in oil and install it on the shifter. Install the shifter through the plate and lever, then rivet the shifter to the lever, Figure 4.
6. Place a new gasket on the cover studs and install the cover assembly. Torque the nuts to 45 ft. lbs.

   NOTE: ***Information on repairing the support and clutch sleeve is covered in Chapter II.***

B. Select-O-Speed P.T.O. Control Assembly Repair

1. Pull out on the control handle and unscrew the nut so the knob assembly is free, as shown in Figure 5.
2. Unscrew the conduit nut at the transmission cover, Figure 5. Loosen the conduit nut at the front end of the knob assembly, Figure 5, then turn the P.T.O. handle clockwise until the cable is free from the transmission.
3. Knock out the handle pin, see the insert, Figure 5, and remove the handle, nut, and lock washer.
4. Remove the conduit and knob-cable assembly. Unscrew the conduit nut at the knob-cable assembly and pull out the cable assembly.
5. Inspect the conduit for kinks or breaks. Inspect the cable for wear or damage.

   Series 601 Tractor Knob-Cable Assembly: The knob-cable assembly used on Series 801 and 901 tractors is also used on the Series 601 Tractors. However, in order to use this cable on the 601 Series, it must be shortened. Push the control handle into the control body and cut the cable so that 25½" extends from the body. Grind the end of the cable round and smooth.
6. Install the knob-cable assembly in the conduit and install the conduit nut but do not tighten at this time.
7. Position the conduit and knob-cable assembly on the tractor. Slide the lock washer, nut, and handle on the knob-cable assembly, then secure the handle with the pin, shown in the insert, Figure 5.

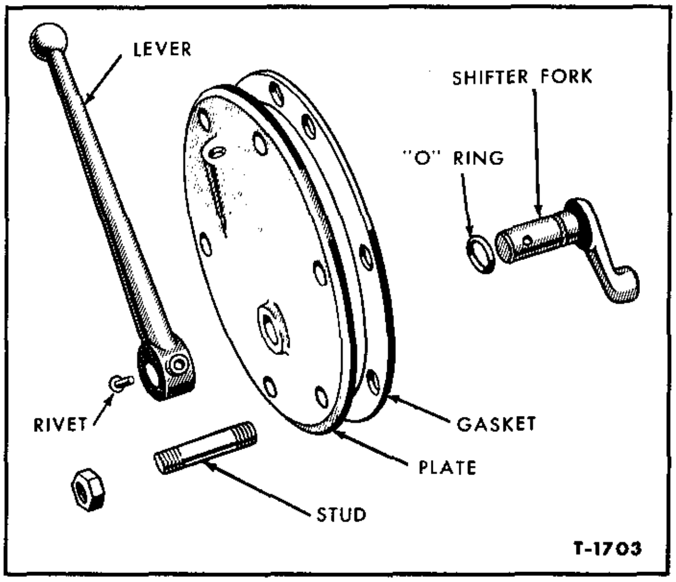


Figure 4—P.T.O. Shift Lever Assembly

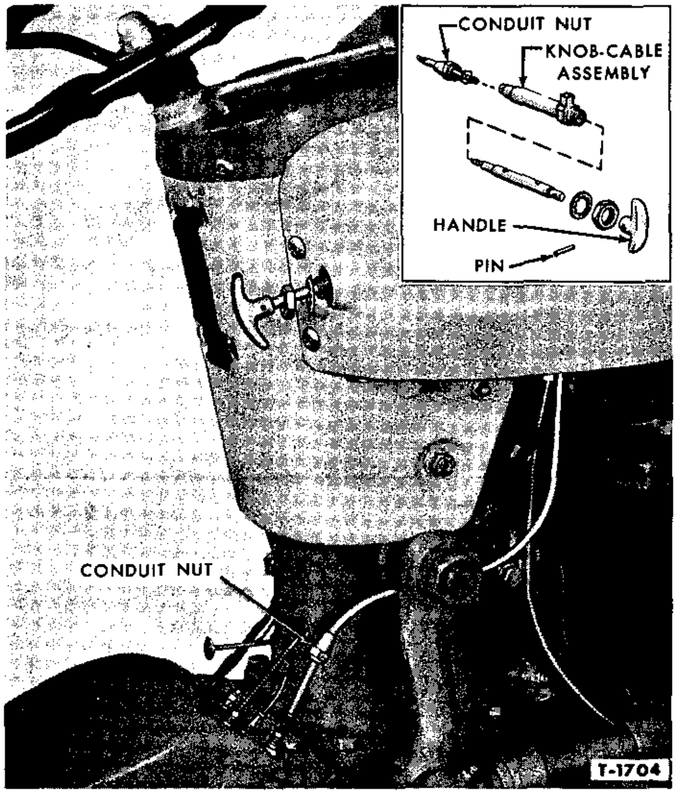


Figure 5—Select-O-Speed P.T.O. Handle

8. Pull the handle out (rearward) and feed the P.T.O. cable into the transmission by turning the handle counterclockwise until the lower end of the conduit is tight against the cover fitting.
9. Position the knob-cable assembly so the tab in the hood engages the groove in the knob. Tighten the nut to secure this position.
10. Tighten the top and bottom conduit nut and check the P.T.O. control assembly for ease of operation. Also check for P.T.O. disengagement with the handle "IN". If the transmission lubrication light is on, other than when the knob is at a midway position, the cable is not threaded far enough into the transmission.

2. POWER TAKE-OFF CONVERSION ASSEMBLY

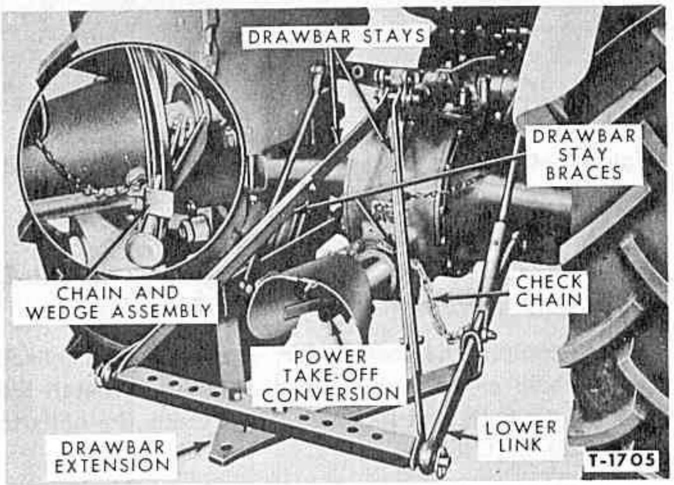


Figure 6—Power Take-Off Conversion Installed

A Power Take-Off Conversion Assembly is available as optional equipment, for use on Ford Tractors with a 1⅛" diameter P.T.O. shaft. The assembly includes a P.T.O. extension, safety shield, draw bar extension and draw bar stay braces.

The power take-off extension has a 1⅜" splined shaft and meets the American Society of Agricultural Engineers specifications for a standard tractor hitch. Any implement built to A.S.A.E. standards may be hitched to the Ford Tractor with this assembly. The Power Take-Off Conversion Assembly is shown installed in Figure 6.

A. Disassembly

1. Remove the four conversion assembly to center housing bolts and pull the assembly off the P.T.O. shaft.
2. Remove the shield, cover, and shim pack, Figure 7. Tag the shim pack for later assembly.
3. Tap the shaft out toward the rear of the housing.

   NOTE: ***The rear bearing cup will also come out with the shaft.***
4. Inspect the bearings for scored or worn rollers. Inspect the cups for signs of heating or scoring. Check the shaft and sleeve for damaged splines.

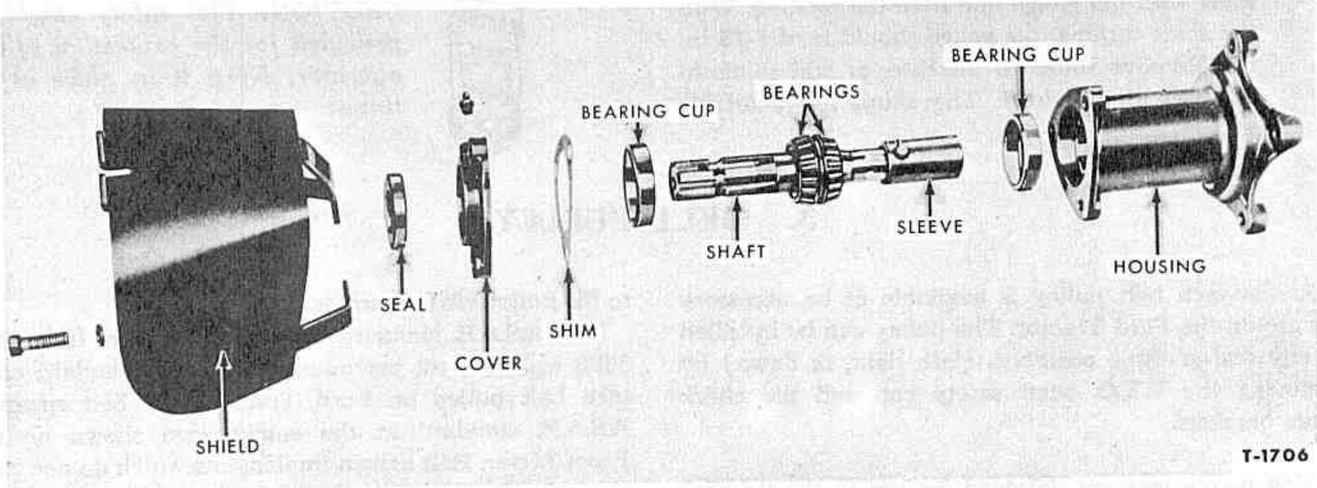


Figure 7—Power Take-Off Conversion Assembly

B. Overhaul

1. Press the dust seal out of the cover. Use a lube gun and check to make sure grease can flow through the lube fitting.

   NOTE: ***Wait until preload is established before installing the new seal.***

2. Pull the shaft rear bearing with Bearing Pulling Attachment 951, and a press.
3. Remove the rivet from the shaft and sleeve, Figure 7. Pull the sleeve off the shaft.
4. Use Bearing Pulling Attachment 951 and press the front bearing off the shaft.
5. Press on new bearings making sure they are seated on the shaft.
6. Install the new sleeve and rivet it to the shaft.
7. Secure the housing in a soft jawed vise and pull the bearing cup with Slide Hammer and Attachment 943. Press in a new front cup using a suitable step plate.

C. Assembly

Preload must be established before the housing is bolted to the center housing.

1. Grease the bearings and insert the shaft in the housing.
2. Install the rear bearing cup, shim pack, cover, bolts, and lock washers. Tap the cover a few times with a soft-head hammer and torque the bolts to 40-50 ft. lbs.
3. Use Gauge 4609-A on the splined end of the shaft, Figure 8, and check the preload. Turn the shaft with the gauge and note the reading. With the shaft turning, the gauge should read 5-15 in. lbs. Remove shims to increase, or add shims to decrease the preload. The shims are available in 0.003", 0.005", and 0.012" thickness.

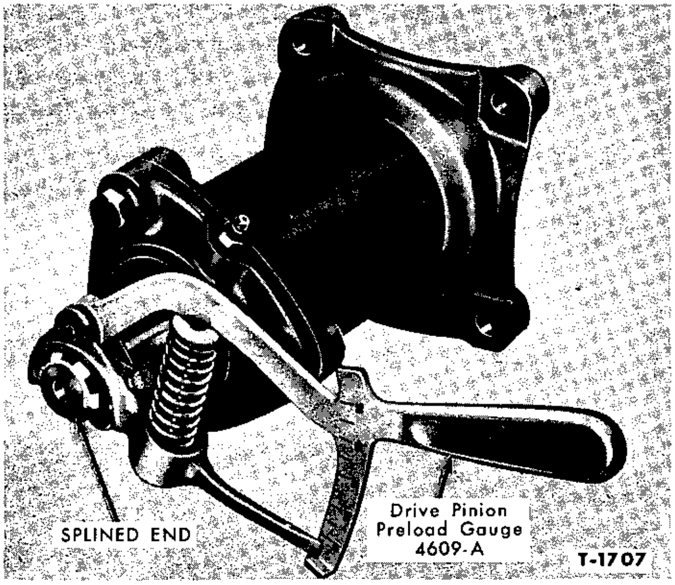


Figure 8—Checking Power Take-Off Conversion Preload

   NOTE: ***When used bearings are installed, hold preload to low side (5-7 in. lbs.)***

4. Position the conversion assembly and check chain anchors on the center housing. Install the four bolts and lock washers. Torque the bolts to 40-50 ft. lbs.

   NOTE: ***The check chains must be attached with the short section of the bracket on top. If the brackets are not installed correctly, it is impossible to raise the lower links to the top of their travel.***

5. Install the dust seal, shield, and grease the assembly through the lube fitting. Check the operation of the shaft.

CAUTION: ***The safety shield is provided for the protection of the operator. Keep it in place at all times.***

3. BELT PULLEY

A nine-inch belt pulley is available as an accessory for use on the Ford Tractor. The pulley can be installed in any one of three positions, (left, right, or down) by removing the P.T.O. shaft safety cap and the check chain brackets.

The pulley was not designed for use in the up position because it does not allow an adequate supply of oil to the pulley shaft bearings.

The A.S.A.E. standard belt speed for farm tractors is 3000 to 3200 feet per minute. With the standard nine-inch belt pulley on Ford Tractors, the belt speed is A.S.A.E. standard at the engine rpm shown on the Proof-Meter. Belt driven implements which do not meet the A.S.A.E. standards should be operated at the speed recommended by their manufacturer.

To obtain this speed, select a driven pulley of the proper size from the table below.

CAUTION: ***Do not operate the belt pulley with the engine P.T.O. shift lever in the 1000 rpm position.***

PROPER SIZE OF THE DRIVEN PULLEY*

Engine R.P.M. 4-Speed Trans-mission	Engine R.P.M. Select-O-Speed Trans. (Low Range)	Engine R.P.M. 5-Speed Trans-mission	Nine Inch Pulley R.P.M.	R.P.M. OF THE DRIVEN PULLEY								
				600	800	1000	1200	1400	1800	2200	2600	3000
1000	1154	1168	679	10	7½	6	5	4½	3½	3		
1100	1269	1285	747	11	8½	6½	5½	5	3½	3		
1200	1385	1402	815	12	9	7½	6	5	4	3½	3	
1300	1499	1517	882	13	10	8	6½	5½	4½	3½	3	
1400	1614	1634	950	14	10½	8½	7	6	4½	4	3½	3
1500	1730	1751	1018	15	11½	9	7½	6½	5	4	3½	3
1600	1845	1868	1086	16½	12	10	8	7	5½	4½	4	3½
1700	1961	1985	1154	17½	13	10½	8½	7½	6	4½	4	3½
1800	2076	2102	1222	18½	13½	11	9	8	6	5	4	3½
1900	2192	2219	1290	19½	14½	11½	9½	8½	6½	5½	4½	4
2000	—	—	1358	20½	15½	12	10	8½	7	5½	4½	4

*Figures are computed to the nearest ½ inch pulley size

A. Installation

The new belt pulley assemblies are shipped without oil. Make sure the units are lubricated at the time of installation.

P.T.O. Shaft 1 ⅛" Diameter: The late model P.T.O. belt pulley assembly has a 1⅜" female spline. To install this assembly on early model tractors, the 1⅛" shaft must be equipped with a 1⅛" to 1⅜" adapter. See the insert in Figure 9.

Remove the P.T.O. cap, the swinging drawbar, hanger, or check chain anchor links, and bolt the belt pulley assembly on the tractor. Torque the bolts to 35-40 ft. lbs.

P.T.O. Shaft 1 ⅜" Diameter: Remove the P.T.O. cap and install the pilot spacer, Figure 9, in the end of the P.T.O. cover. Seat the spacer with a soft-head hammer. Position the belt pulley assembly on the housing, center it on the pilot spacer, and bolt it to the center housing.

B. Disassembly

1. Remove the filler plug and drain the lubricant out of the pulley housing.
2. Remove the cover and discard the gasket.
3. Remove the cotter pin, Figure 9, and loosen the slotted nut. Drive the pulley shaft out against the nut, then remove the nut and washer.
4. Remove the driven gear, bearing, and splined bushing, Figure 9. Pull the pulley shaft assembly out of the housing.
5. Lift the drive gear assembly out of the housing.

C. Inspection

Clean all the parts in solvent prior to inspection.

1. Inspect the bearing cups for signs of overheating or scoring. Inspect the housing for cracks, or stripped threads.
2. Inspect the bearings for scored or worn rollers.
3. Check the gears for broken, worn or chipped teeth.
4. Inspect the pulley shaft for damaged splines, threads, or elongated pulley holes. Check the pulley for a worn belt surface or looseness on the shaft.

D. Overhaul

Cover: Pull the bearing cup with slide Hammer 943-S and Puller 956-2. Press in a new cup.

Drive Gear: The drive and driven gears are a matched set. If either gear is damaged, both gears must be replaced.

1. Pull the drive gear pilot bearing with Puller Attachment 950, a press, or Legs 930-E, Pads 930-7, and Push Puller 938. Press on the new bearing.
2. Use the tools mentioned in step 1 and pull the drive gear front bearing, Figure 9. Install the new bearing with a 1¾" I.D. sleeve and press.

Housing:

1. Pull the oil seals with Puller 956-2 and Slide Hammer 943-S.
2. Pull the pulley shaft outer bearing and cup with Puller Attachment 950. Also pull the drive gear front bearing cup.
3. Drive the pulley shaft inner bearing cup from the housing with a punch and hammer. Install the new cup with Plate FT-506 and Slide Hammer 943-S. Make sure the cup is seated in the housing.
4. Press the remaining cups and oil seals (use new seals and face the lips inward) in the housing with Step Plate Set 630-S.

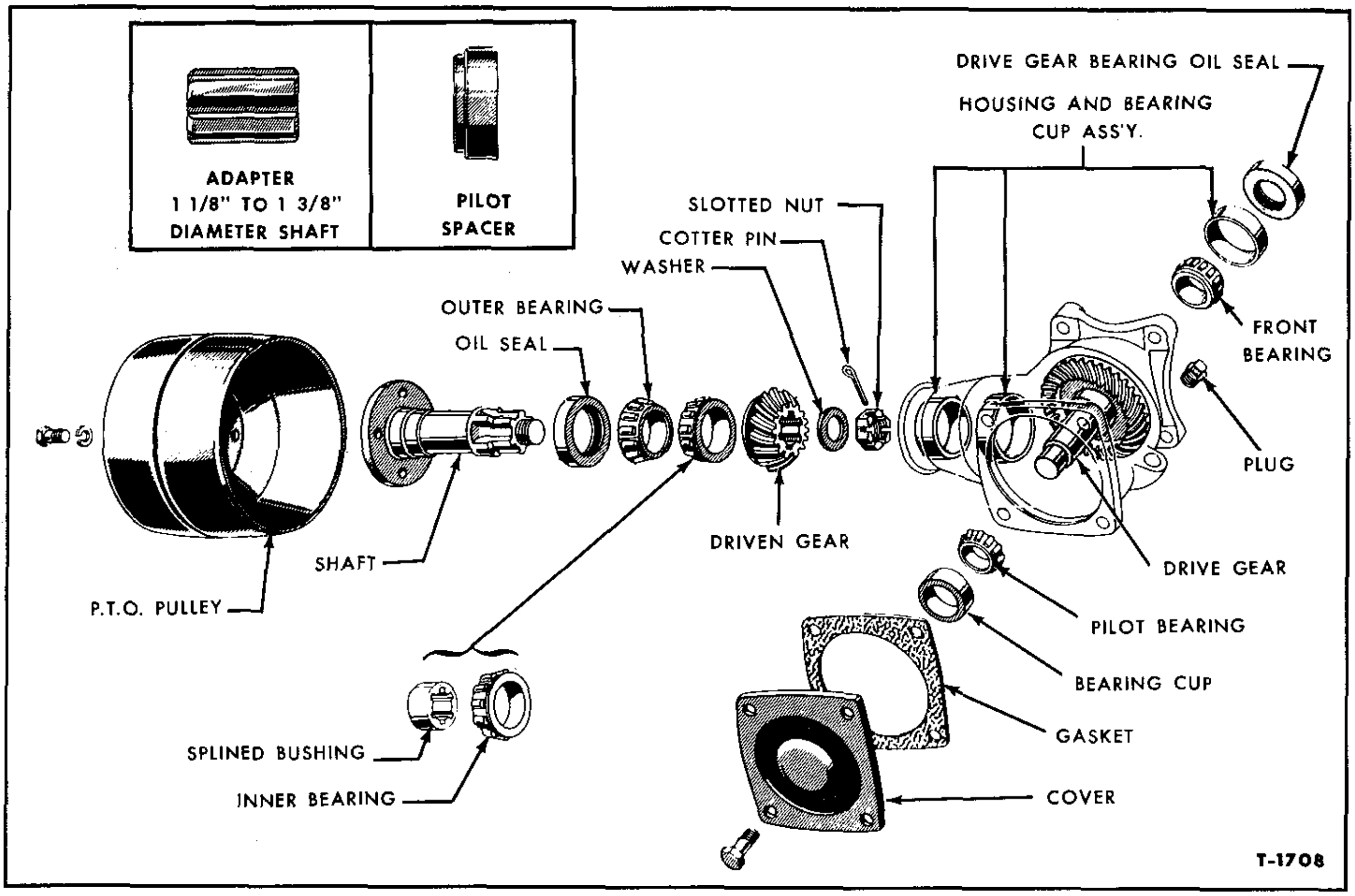


Figure 9—Belt Pulley Assembly

NOTE: *Make sure the pulley shaft outer bearing is positioned inside the seal.*

E. Assembly

1. Grease the bearings and coat the oil seals with suitable lubricant.
2. Insert the drive gear assembly. Position the driven shaft inner bearing, splined bushing, and driven gear in the housing. Insert the pulley shaft, and as the threaded end comes through the driven gear, install the washer and slotted nut.
3. Tap the pulley shaft with a soft-head hammer and tighten the slotted nut to establish a preload.
4. Install the pulley, then wrap a cord around it and attach Pull Scale 3600-E. Pull, and with the shaft turning, note the preload. Preload should be 2 to 3 lbs. pull on a 9" diameter pulley. If necessary, tighten the nut to increase the amount of preload. Install the cotter pin to secure the adjustment.
5. Install the gasket and cover assembly and tighten the four cover bolts.
6. Wrap a cord on the pulley and check the total preload. The correct total preload (with the shaft turning) is 3-5 lbs. Different thickness gaskets (0.008" to 0.023") are available to adjust preload. The thicker gaskets give less preload.
7. Fill the housing with M-4864-B lubricant to the level of the plug opening. Install and tighten the plug.

4. SPECIFICATIONS

Preloads

Description	Preload	Taken at
P.T.O. Conversion Assemblies	5-15 in. lbs.*	Splined end of shaft
Belt Pulley Pulley Shaft	2-3 lbs.*	Cord on 9″ Pulley
Total	3-5 lbs.*	Cord on 9″ Pulley

*Use the small figures for "broken in" assemblies.

Nut and Bolt Torque

Description	Ft. Lbs.
P.T.O. Cover Bolts	35-40
Shift Lever Studs	40-45
Shift Cover Nuts	45
P.T.O. Conversion Cover Bolts	40-50
Conversion to Center Housing Bolts	40-50
Belt Pulley Assembly to Center Housing Bolts	35-40

Shims and Gaskets

Description	Thickness
P.T.O. Conversion Cover Shims	0.003″, 0.005″, 0.012″
Belt Pulley Cover Gasket	0.008″ to 0.023″

5. SPECIAL TOOLS

The following tools are required to properly service the Power Take-Off assembly.

Tool No.	Description
4609-A	Drive Pinion Preload Gauge
630-S	Step Plate Set (No. 1-11)
630-T	Step Plate Set (No. 12-17)
1003	Puller
943	Slide Hammer and Attachment

Tool No.	Description
956-2	Pilot Bearing Puller
950	Bearing Puller Attachment
951	Bearing Puller Attachment
930-E	Legs
930-7	Pads
938	Push Puller
FT-506	Plate
3600-E	Pull Scale
▲▲	Sleeves 1½″ I.D., 1¾″ I.D.

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS AND TIRES

Chapter

1-A

Power Steering—General Purpose Tractors

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1. CONSTRUCTION AND OPERATION

Power steering information on this page through Page 300, applies to "General Purpose" tractors. For power steering information on other models, see Pages 301 to 322 ("Row Crop" tractors) or Pages 323 to 340 ("Industrial" tractors.)

The steering mechanism comprises all the units of the tractor that have to do with directional control. These units are: steering wheel, steering column, steering gear, Pitman arms, drag links, oil pump, control valve, power cylinder and steering arm, Figure 1.

The system utilizes the conventional mechanical Ford Tractor steering gear and linkage plus a hydraulic pump, a control valve, two power cylinders, and hoses and tubing to provide a power assist in all steering operations.

In the event of power assist failure, the mechanical components provide complete steering control at all times.

A. Drag Link

The drag link assembly, consisting of the drag link and the drag link adjusting sleeve, is the steering linkage between the Pitman arm, attached to the steering gear, and the steering arm connected to the front spindle, Figure 1. "General Purpose" tractors have two drag links, one on each side of the tractor. Under certain conditions, such as in the adjustment of the position of the front axle, it is necessary to change the length of the drag links. Make sure that the drag links are adjusted equally to maintain the straight-ahead position of the front wheels. Instructions for making this change are detailed in the FRONT AXLE chapter.

B. Power Steering Pump

Sleeve Type: Early model tractors are equipped with a sleeve-type pump and an attached oil reservoir mounted at the front right side of the engine, Figure 1.

The pump body contains a drive cylinder block and a driven cylinder block, each containing nine holes. The two cylinder blocks are set at an angle to each other and their respective holes are connected in pairs by specially formed hollow sleeves. The drive cylinder block is splined to the pump shaft. The rotation of the drive cylinder block is transmitted to the driven cylinder block by the mechanical connection of the nine bent sleeves. The pump shaft is supported by a sealed ball bearing assembly and a lip-type, spring-loaded oil seal at the pulley end. At the inner end, the shaft is supported by a bronze bushing.

Because of the angle between the cylinder blocks, the effective lengths of the holes (which are connected by the bent sleeves) are greater at one point in their rotation than they are 180° from that point. Oil passes into the holes at the point where this effective length is greatest. As the rotation of the blocks shortens this effective length, oil is forced out the pressure side of the pump.

At low engine speeds, the full delivery volume of the pump is required to provide power assistance for rapid steering. At higher engine speeds, the full delivery volume of the pump is in excess of requirements.

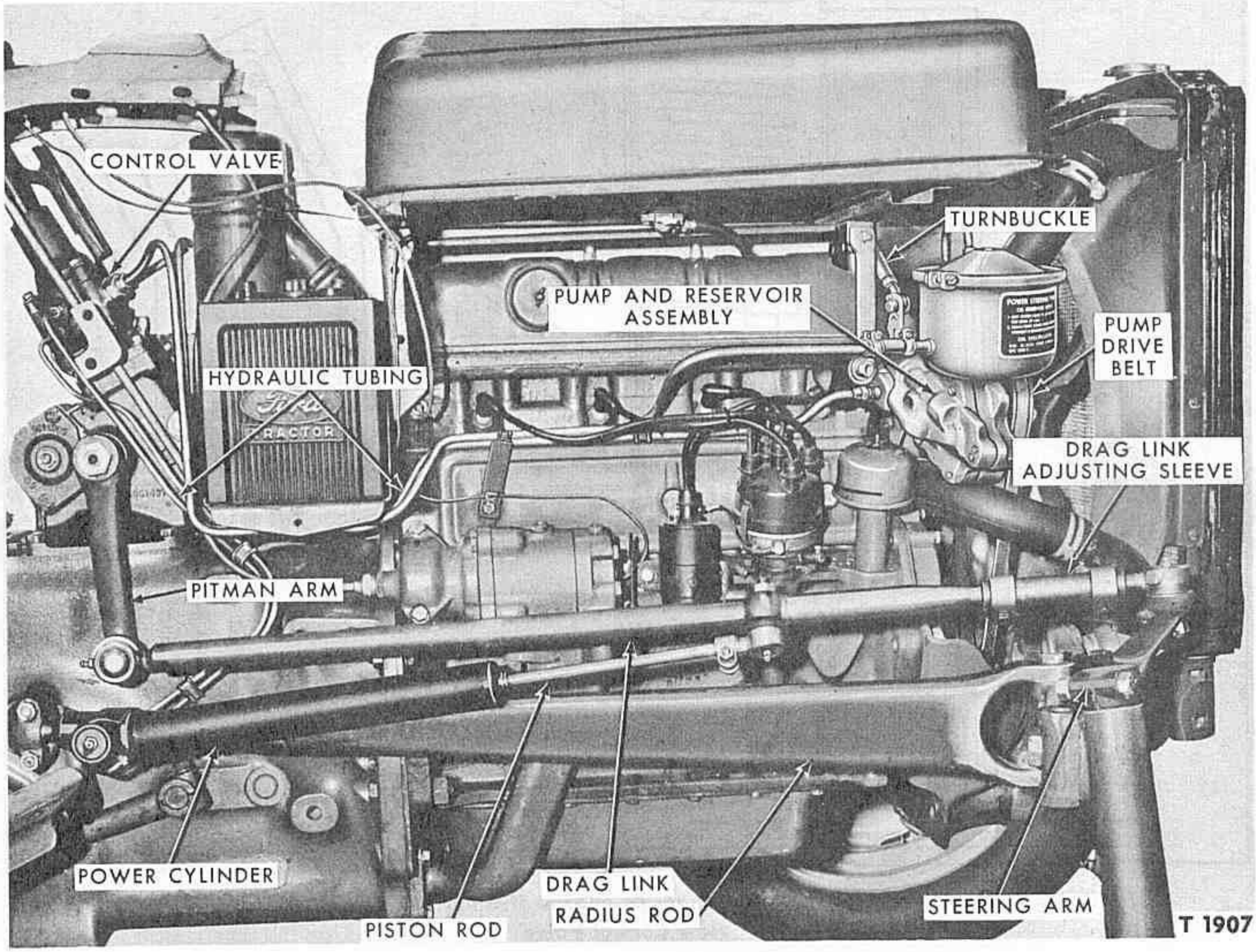

Figure 1—Components of the Power Steering System

To avoid circulating the excess fluid through steering control valve and tubes, a spool-type, spring-loaded flow control valve is provided in a bore in the pump body.

The flow control valve, which is hollow and closed at one end, has a small metering orifice in its wall. A spring-loaded, ball-type, pressure relief valve is mounted inside the flow control valve spool. The ball and spring are held in place by a threaded valve seat.

The pump flow control valve functions as follows:

Oil from the pump flows through the pump delivery passage, Figure 2, to the steering control valve. Within the pump delivery passage, there is an orifice "B". The flow control valve assembly has a sliding spool "I". The lower end of this spool, "A", is connected to the pump delivery passage *ahead* of orifice "B", while the upper end of this spool, "D", is connected to the pump delivery passage *beyond* orifice "B" by means of passage "C". When the pump is driven slowly, orifice "B" offers small resistance to the flow of oil and the pressure at "A" is almost exactly the same as the pressure at "D". The flow control valve spool is, therefore, very nearly in hydraulic balance and is easily held in the downward position by compression spring "F". All of the oil delivered by the pump flows to the steering control valve.

When pump delivery is increased (by increasing engine speed) the orifice "B" will cause the pressure at "A" to increase more than the pressure at "D", and the valve spool moves toward spring "F". This action uncovers a port in the pump body at "G" and permits excess oil to flow back to the reservoir. Thus, regard-

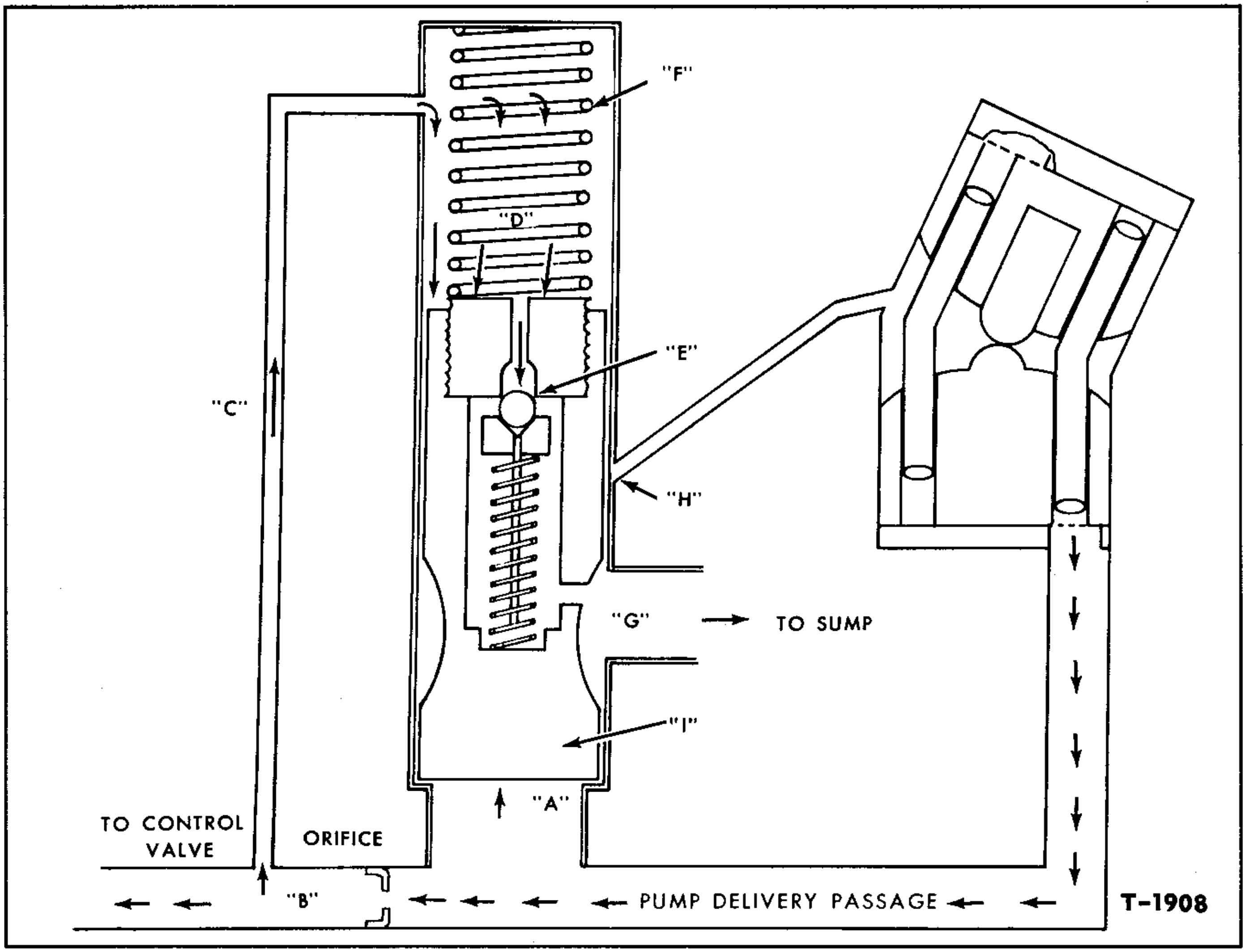

Figure 2—Flow Diagram—Power Steering Pump Flow Control Valve

less of engine speed or pump pressure, pump output is limited to the maximum flow as shown in the chart.

The flow control valve limits pump output as follows:

OIL PUMP FLOW CHART

Pump rpm	Pump gpm	psi
1250	4.75 to 5.25	600
3000	5.50 to 6.50	100
700	2.80 Minimum	600

Relief Valve Setting—700 to 800 psi
Oil Temperature—150° F.

Pump pressure in the flow control valve is limited to a maximum of 800 psi by means of a pressure relief valve. When pressure in the system exceeds the relief valve setting of 700 to 800 psi, the ball "E" is unseated and pressure is relieved. Oil passing through the relief valve inside the valve spool is transmitted to the reservoir through a small orifice in the spool wall. The operation of the relief valve limits system pressure to a maximum 800 psi regardless of the position of the flow control valve. The pump reservoir fits over the rear of the pump so that the pump body is submerged in the reservoir. A clamp ring and rubber seal hold the reservoir in position and prevent external leakage. A replaceable filter element is installed on the return line inside the reservoir. A spring-loaded, ball-type relief valve, installed in the return line ahead of the filter, permits oil to bypass directly to the reservoir if the filter becomes clogged. During operation, oil enters the pump through a pump inlet submerged in the reservoir. Correct oil level is indicated by a dipstick attached to the filler cap.

Roller Vane Type: Late model tractors use a roller vane type pump. For a complete description of this pump, and the overhaul procedures, see Page 327 in Chapter 1-C.

C. Steering Gear

NOTE: *The power steering system on "General Purpose" tractors is an "assist" type. The mechanical steering system with linkage connections provides manual steering or initiates the power steering operation. For these reasons, and because the mechanical steering system can be used independent of the power equipment, it is important that all mechanical components be included in this manual.*

"General Purpose" tractors use a recirculating ball nut-type steering gear, Figure 3. Anti-friction steering is achieved by the steel balls which serve as rolling contacts between the nut and the worm.

Turning the steering wheel (which also turns the steering shaft and worm) moves the ball nut up and down along the worm. A rack on the outside of the ball nut engages the right sector and shaft assembly which, in turn, is engaged to the left sector and shaft assembly. Any movement of the ball nut rotates each sector the same number of degrees, but in opposite directions.

A Pitman arm attached to the outer end of each sector shaft assembly transfers the motion of the sector shafts through the drag links to the steering arms which turn the front wheels.

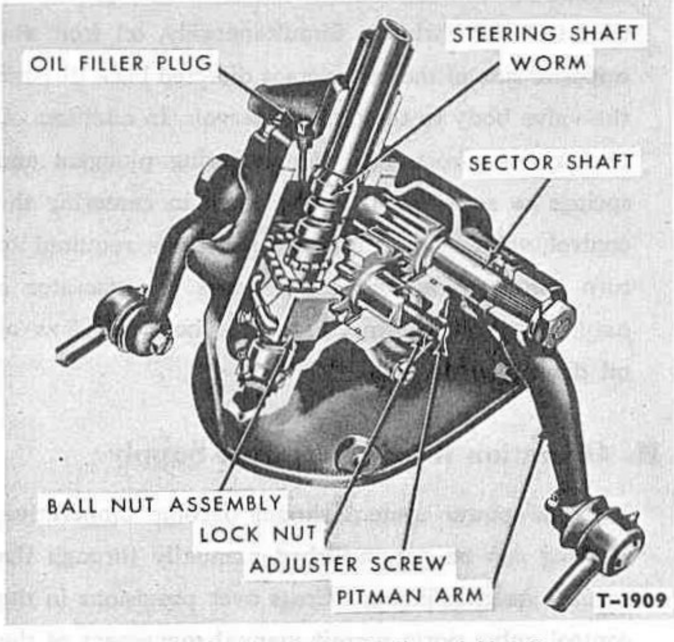

Figure 3—Recirculating Ball-and-Nut-Type Steering Gear

D. Control Valve

The control valve is mounted on the steering shaft on the upper end of the steering gear housing, Figure 18. It consists principally of a valve housing, valve spool, six centering plungers, three centering springs, one pump return port anti-cavitation check valve assembly, and two anti-cavitation and reaction plunger assemblies, Figure 20.

A ball-thrust bearing, mounted at each end of the valve housing, holds the valve and the six centering plungers in position. A staked nut at the upper end holds the entire assembly tight against the steering shaft worm shoulder, Figure 19.

Two counterbores in the end faces of the valve housing permit a slight axial movement of the steering shaft worm, valve, and bearing assemblies.

Three sets of centering plungers and springs mounted in the valve housing, bear against the ball-thrust bearings and tend to hold the valve at the midpoint of its allowable axial play. This is the valve's neutral position.

The control valve housing has six external ports: one to the reservoir, one pump inlet, and a pressure and return port for each of two power cylinders.

In operation, oil under pressure is delivered from the pump to the control valve. When the steering wheel is turned, the resistance of the ball nut (engaged to the sector) to the worm will tend to move the worm, shaft, and valve up or down, depending on which way the wheel is turned. Maximum movement of the valve is 0.070 inch (0.030 to 0.035 inch either side of neutral). This axial movement of the valve directs oil under pressure to the power cylinders. When the steering wheel turning action is stopped, the steering shaft thrust is removed. This permits the centering springs and plungers to return the valve to its center or neutral position. In this position, the pump output will be recirculated in the system without doing any work, as shown in Figure 4.

E. Power Cylinders

"General Purpose" tractors, equipped with power steering, have two double acting hydraulic power cylinders—one for each front wheel. The cylinder housing is anchored to the rear section of the radius rod. The cylinder piston rod is attached to the front section of the drag link, Figure 1. Both attachments are made with end assemblies. Two hydraulic tubing connections are located in the rear of each cylinder. Oil pressure to the cylinders is directed by the control valve in such a way that the cylinders operate in opposite directions from each other.

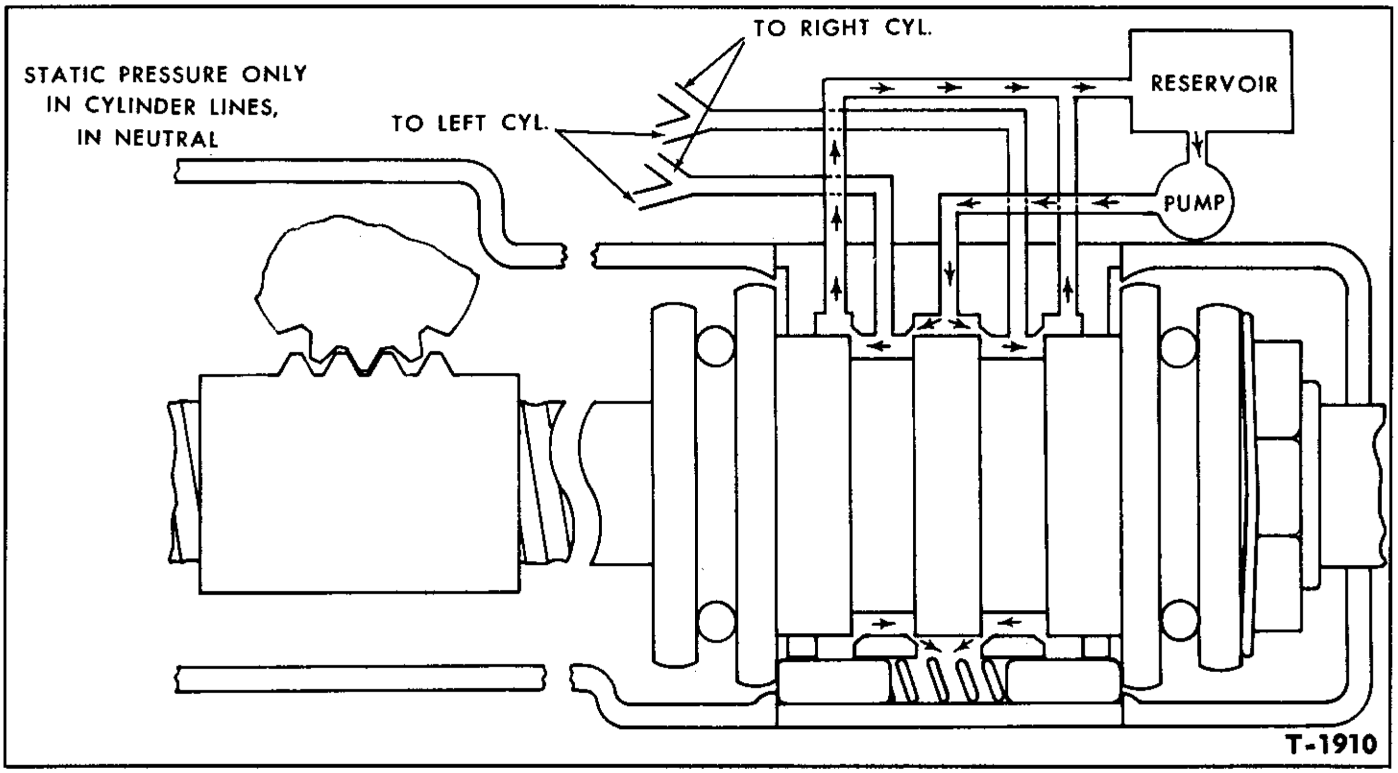

Figure 4—Flow Diagram—Oil Flow with Control Valve in Neutral

F. Straight-Ahead Driving

When the tractor wheels are in the straight-ahead position, the absence of thrust on the steering column worm enables the centering springs to hold the valve in its center or neutral position. In this position, oil entering the control valve is directed back to the reservoir without doing any work, Figure 4.

G. Left or Right Turning

The steering power system operates in the same manner for both left and right turns except for the direction of control valve movement and oil flow. For left turns, the valve moves upward or to the right, as shown in Figure 5.

When the steering wheel is turned, a thrust is developed in the steering shaft and worm. Resistance to this thrust by the steering ball nut and the sector gear creates sufficient axial force to overcome the centering springs in the control valve housing. This permits the steering shaft worm and the valve to move up (or down) thereby directing oil pressure to one side of the power cylinders and providing hydraulic force to the manual effort of the operator to turn the front wheels. Simultaneously, oil from the opposite side of the cylinders is directed back through the valve body to the pump reservoir. In addition, oil pressure is directed to the centering plungers and springs to supplement spring force in centering the control valve. This increases the force required to turn the steering wheel and gives the operator a natural feel of steering. Figure 5 shows the flow of oil during a left turn.

H. Operation Without Pressure Supply

If the power system should become inoperative, steering can be accomplished manually through the regular steering linkage. Cross over provisions in the control valve ports permit manual movement of the power cylinders with an increase in the steering effort.

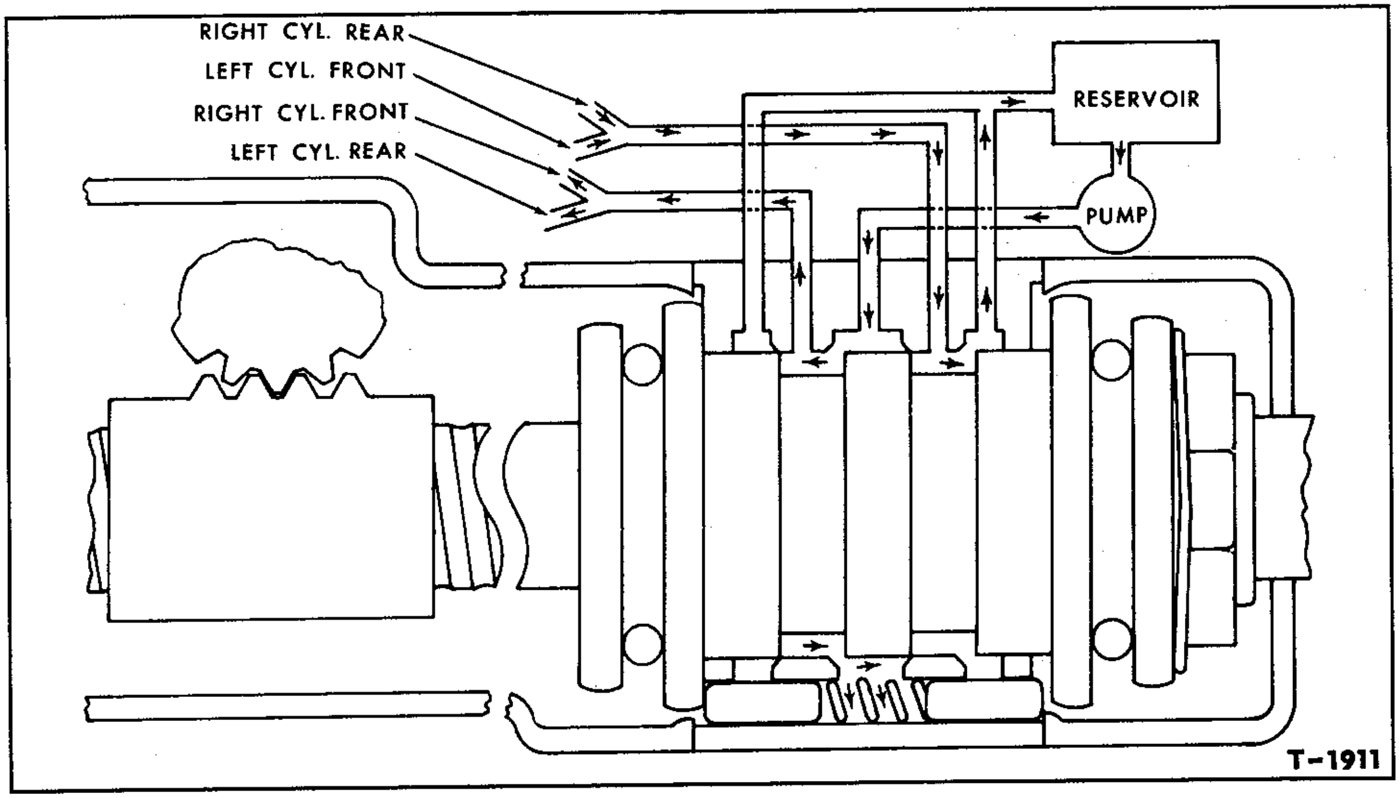

Figure 5—Flow Diagram—Oil Flow With Control Valve in Left Turn Position

2. DRAG LINK

A. Removal

1. Remove the nut and disconnect the front end of the power cylinder from the drag link with a suitable puller.
2. Remove the cotter pin and castellated nut from each end of the drag link and disconnect it from the steering arm and the Pitman arm with a suitable puller.
3. Loosen the clamp bolts then turn the drag link end out of the sleeves.

B. Inspection

1. Examine parts for wear and damage. Replace defective parts.

C. Installation

1. Thread the drag link end into the sleeve. Leave approximately ½″ of the threads visible on the drag link and on the drag link end.
2. Attach the rear of the drag link to the Pitman arm with a castellated nut and cotter pin.
3. Make sure the wheels are in a straight-ahead position and that steering gear is at center of travel. Then, attach the front of the drag link to the steering arm with a castellated nut and cotter pin. Use the sleeve adjustment to insure proper alignment.
4. Tighten the clamp bolts.
5. Attach the power cylinder to the drag link.

3. POWER STEERING PUMP—SLEEVE TYPE

A. Removal

1. Disconnect the pressure line from the top of the pump body.
2. Disconnect the pump return line from the rear of the reservoir. Cap the pump reservoir inlet.
3. Loosen the turnbuckle and remove the drive belt.
4. Remove the cotter pin and the clevis pin from the turnbuckle. Separate the turnbuckle from the pump.
5. Remove the bolt from the pump mounting bracket and remove the pump.

B. Disassembly

1. Drain oil from the pump and the reservoir.
2. Plug the pressure and the return line openings to prevent dirt from entering the pump. Clean the pump exterior thoroughly.

   NOTE: ***Make sure the bench and disassembly area is thoroughly clean.***
3. Remove the reservoir clamp ring and separate the reservoir from the pump body, Figure 6.
4. Remove the retaining bolt, lock washer, and spacer from the end of the pump shaft.
5. Use a puller to remove the pulley from the shaft. (Do not lose or damage the Woodruff key.)
6. Mount the pump in a vise so that the vise grips the turnbuckle attaching surface. Loosen the four hex head bolts which attach the inlet end cover to the pump body, Figure 7.

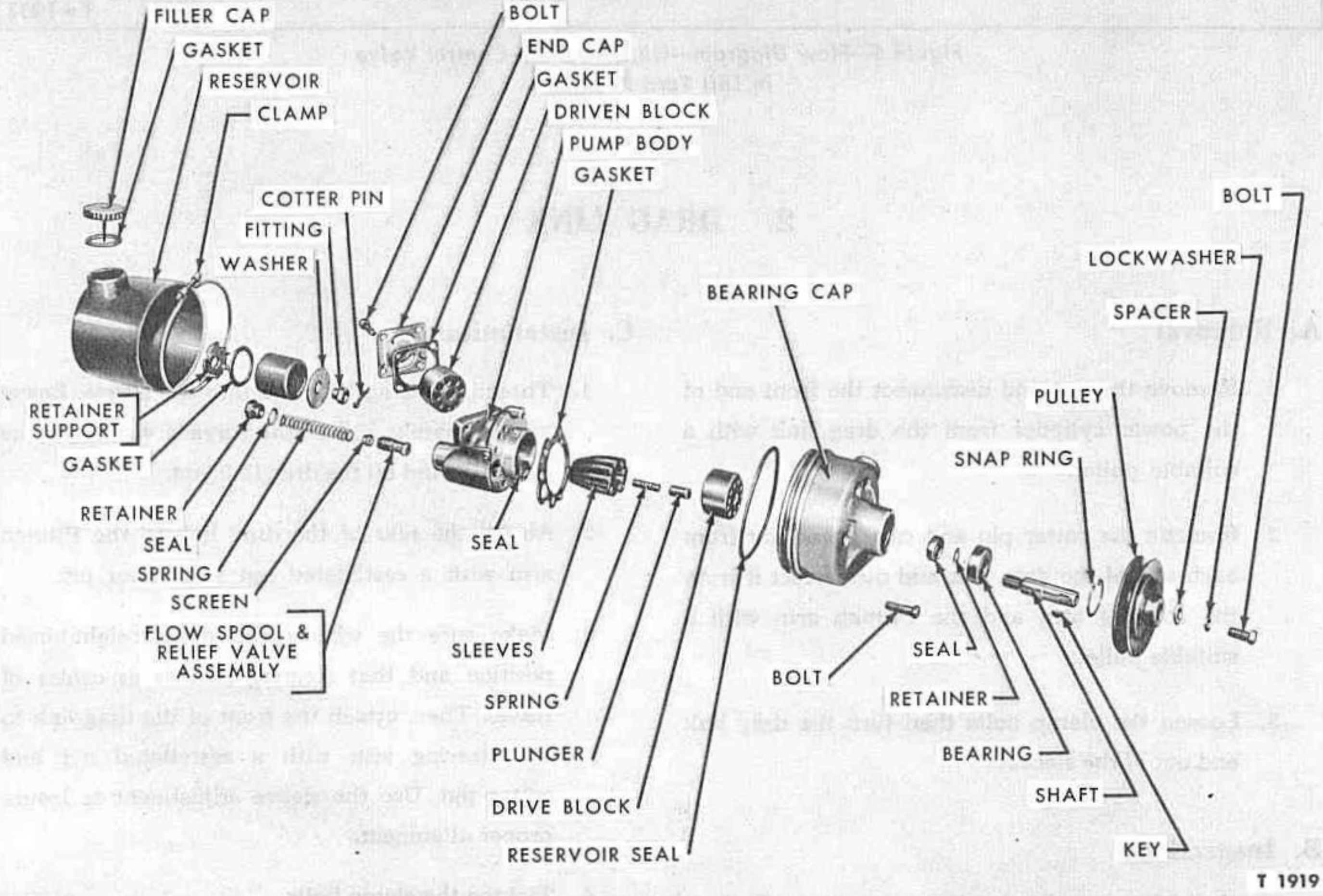

Figure 6—Sleeve-Type Pump—Disassembled View

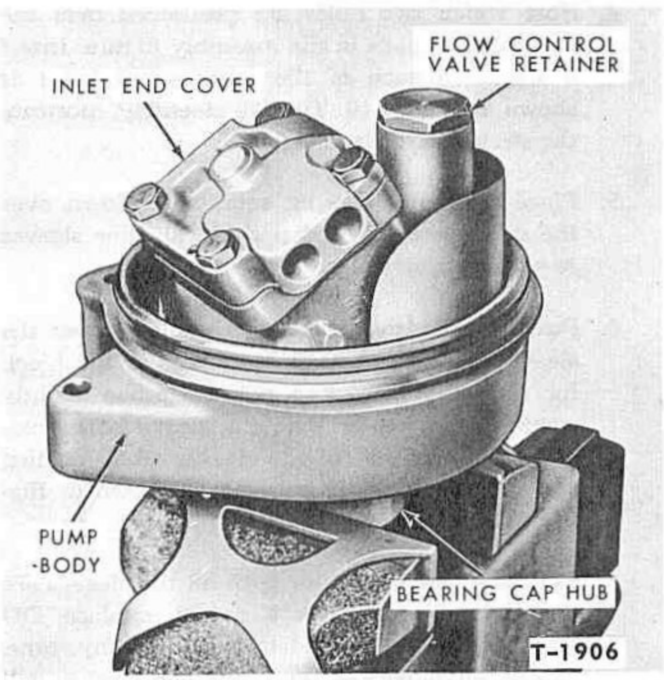

Figure 7—Sleeve-Type Pump with Reservoir Removed

7. Loosen the flow control valve plug and remove the pump from the vise. Remove the plug, seal, spring, screen, and spoon. Ease the plug off carefully so that the spring will not fly out.
8. Mount the pump body in a vise and remove the five hex head bolts from the bearing cap.
9. Remove the pump from the vise and separate the bearing cap and the inlet end cover from the pump body. The cylinder blocks will push out of the pump body slightly due to the pressure of the plunger spring between the blocks.
10. Remove the two cylinder blocks, nine sleeves, plunger, and spring from the pump body.
11. Remove the snap ring from the bearing cap, Figure 8.
12. Push the shaft assembly from the bearing cap.
13. Remove the cotter pin and the hex head fitting from the top of the filter assembly in the reservoir.
14. Remove the filter, gasket, and retainer support from the reservoir.

C. Cleaning, Inspection, and Repair

1. Wipe the bearing and shaft assembly with a clean, lint-free cloth. DO NOT soak parts in a cleaning solvent because solvent may dilute lubricants sealed into the ball bearing.
2. Inspect the shaft for wear and check the ball bearing for roughness or noisy operation. If the bearing must be replaced, push it from the shaft away from the splined end. Install a new bearing with the trademark side toward the pulley end of the shaft. Press the shaft through the bearing until the retaining ring rests against the inner race of the bearing.

   Examine the retaining ring and replace it if it is worn or distorted. Make sure the retaining ring seats in the groove on the shaft and that it is between the bearing and the splined end of the shaft.
3. Check the sleeves to make sure they slide freely in the cylinder block bores. Examine the mating surfaces of the sleeves and the bores for heavy scoring which can impair pumping efficiency. Replace the sleeves or cylinder blocks if scored.
4. Examine the flow control valve and valve liner for burrs or scratches which might cause the valve to stick. Insert the valve in the liner and rotate it slightly with a pencil or other soft instrument. The valve must slide freely. If the valve sticks or drags after dirt, burrs, and nicks

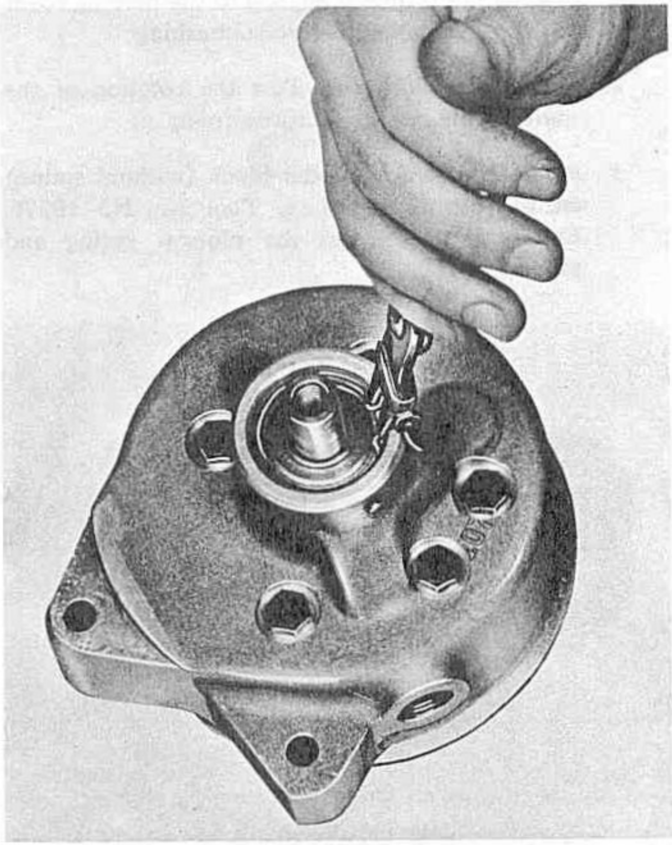

Figure 8—Removing Snap Ring from Pump Bearing Cap

have been removed, replace the valve and/or valve liner.

5. Examine the shaft seal in the bearing cap hub and replace if worn or damaged. Use a puller to remove. Install a new seal with the seal lips facing the casting. Make sure the seal is started right, then press it in until it rests firmly against the casting.
6. Examine the running surface of the bearing cover and the inlet end cover, Figure 12. If scored, or if the port edges are damaged, the part should be replaced.
7. Examine the pump housing. If badly scored or damaged, replace it. Small burrs or scratches can be removed with crocus cloth.

D. Assembly

Make sure that the working area and all parts are thoroughly clean.

1. Press the drive shaft and the bearing assembly into the bearing cover. Use an arbor press and sleeve. Position the sleeve against the outer race of the ball bearing. Make sure the shaft and the bearing are properly aligned to the bearing cover to avoid damaging the bronze bushing.
2. Install the snap ring. Test the rotation of the shaft to make sure it turns freely.
3. Place the driven cylinder block (without spline) on the assembly fixture, Tool No. N3 10776, Figure 9, and insert the plunger spring and plunger.

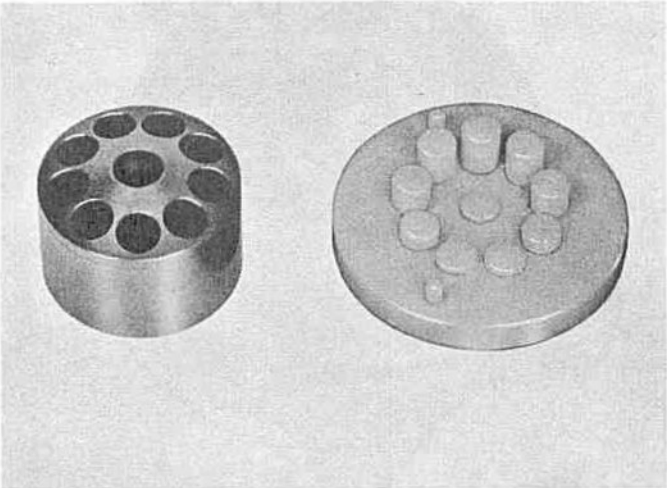

Figure 9—Driven Cylinder Block and Assembly Fixture, Tool No. N3 10776

4. Note which two holes are positioned over the two shortest pads in the assembly fixture. Insert a sleeve in each of the other seven holes as shown in Figure 10. To ease assembly, lubricate the sleeves with clean, light oil.
5. Place the pump housing, square end down, over the cylinder block and position all nine sleeves to a uniform spacing.
6. Position the drive block (with spline) over the sleeves, sighting through the bores in the block for alignment. Using a pointed probe slightly smaller in diameter than the sleeve bores, correct the alignment of the sleeves while guiding the cylinder block downward as shown in Figure 11.

   Continue this procedure until all the sleeves are engaged and the block is firmly in place. DO NOT force the cylinder block at any time. Proper alignment of the block and sleeves will allow the block to be pushed smoothly in place.
7. Install a new seal in the counterbore at the flow control valve liner in the valve body.
8. Using a new gasket, assemble the bearing cover to the pump housing, Figure 12. Make sure the locating pin in the cover engages the locating hole in the pump housing. Install the five hex head bolts finger tight.
9. Remove the housing and the cylinder block assembly from the fixture using care to see that the cylinder block is not pushed out of the housing by the plunger spring.

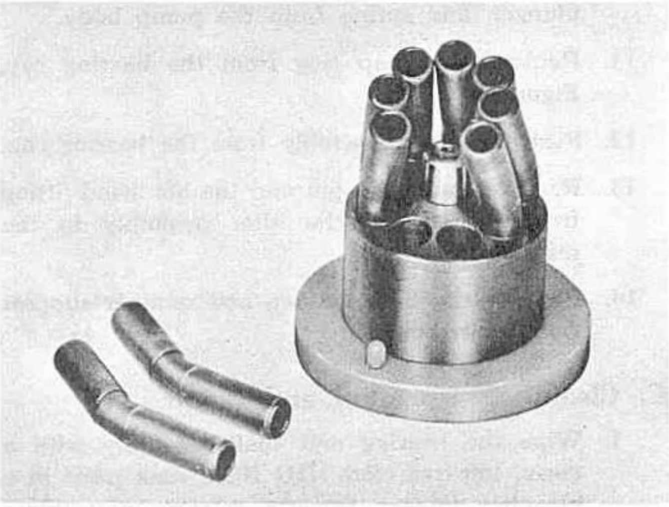

Figure 10—Assembling Sleeves in Driven Cylinder Block

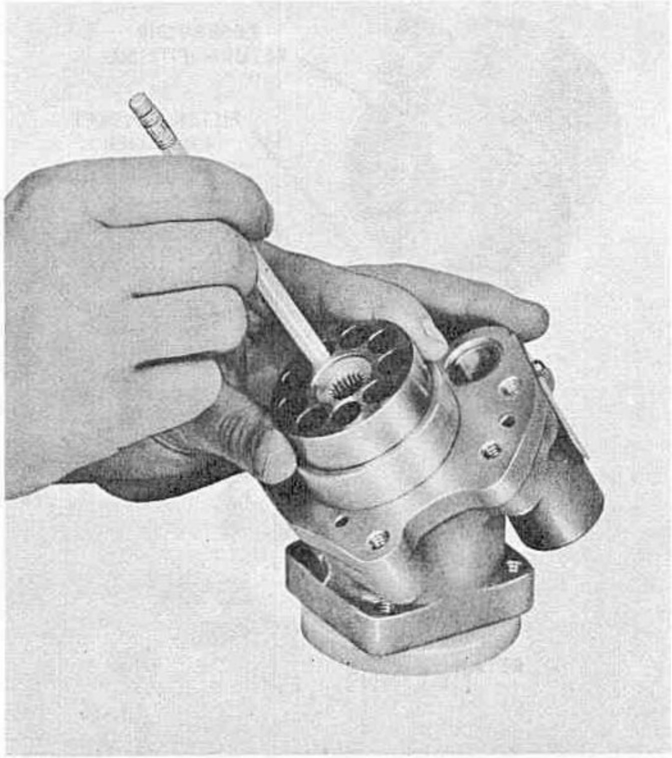

Figure 11—Aligning the Drive Block and Sleeves

10. Install the end cover on the valve body. Use a new gasket and four hex head bolts installed finger tight.
11. Grip the end of the pump shaft in a vise being careful not to score the shaft. Rotate the pump, applying force on the O.D. of the bearing cap. If the pump rotates freely, without binding, tighten the hex head bolts at each end of the pump, one end at a time, to 15 to 20 lb. torque. Check the pump again for rotation.
12. Mount the pump vertically in a vise, gripping the bearing cover hub.
13. Install the flow control valve in its bore with the slotted end up, Figure 13.
14. Install a new "O" ring in the groove on the hex head flow valve plug.
15. Insert the flow valve spring with the filter screen end down.
16. Install the hex head flow valve plug over the spring and tighten until the "O" ring is seated.
17. Install the filter in the reservoir. Fit the filter gasket retainer, a new rubber gasket, and a new filter (in that order) over the reservoir return fitting, Figure 14. Place the filter retainer on the filter and secure it with the hex head fitting and the cotter pin.
18. Install a new reservoir seal in the groove on the bearing cover. Make sure it is not twisted. Lubricate the seal to facilitate the assembly of the reservoir.
19. Slide the clamp ring around the reservoir and press the reservoir, with the filler cap up, into place around the back of the pump. Secure the reservoir to the pump with the clamp ring.
20. Install a new gasket in the reservoir filler neck cap.
21. Install the Woodruff key on the pump drive shaft and align the groove in the pulley with the key. Install the pulley, the spacer, and the lock washer and draw the pulley into position with the hex head bolt that threads into the end of the pump shaft.

    NOTE: ***Make sure there is clearance between the pulley and the shaft bearing.***

E. Installation

1. Position the pump mounting flange at the lower end of the pump to the bracket between the engine and the water pump outlet. Secure with the bolt.
2. Position the drive belt around the pump pulley.
3. Attach the turnbuckle to the pump upper mounting flange with the clevis pin and the cotter pin.

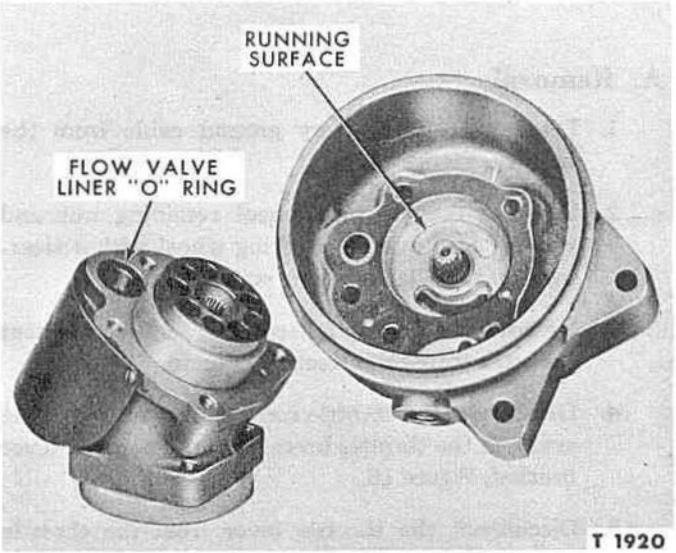

Figure 12—Assembling the Bearing Cap to the Pump Body

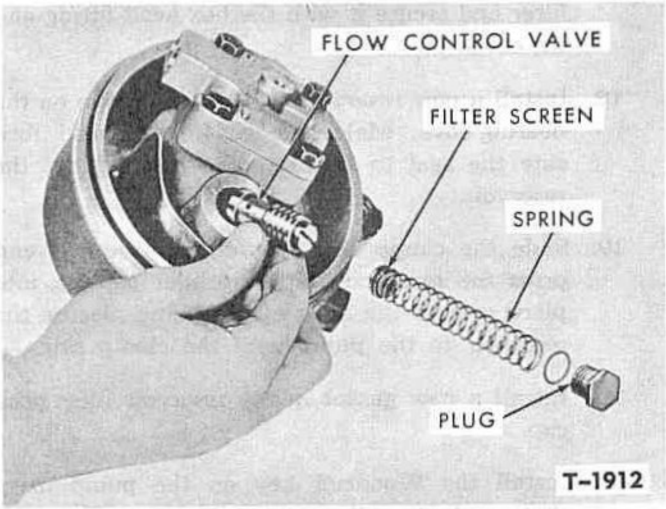

Figure 13—Installing the Flow Valve, Spring, and Retainer Fitting

4. Use the turnbuckle to adjust the belt tension to obtain ¼″ deflection halfway between the pulleys under 15 to 20 lbs. pressure.

5. Connect the pump pressure line to the port at the top of the pump.

6. Fill the reservoir to the proper level with Ford M2C41 hydraulic oil.

7. Bleed air from the system by operating the engine at idle speed.

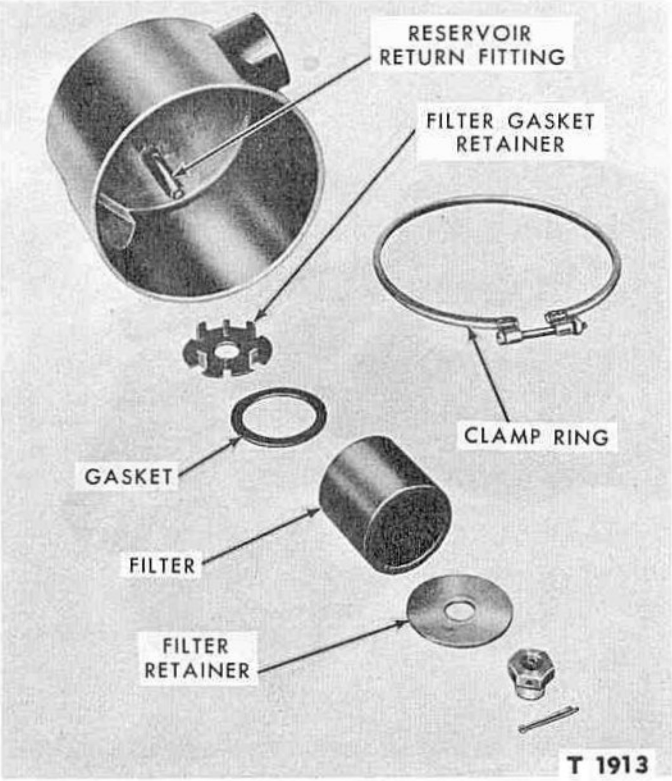

Figure 14—Reservoir Filter Assembly—Disassembled

8. After turning the steering wheel through its complete range several times, stop the engine and fill the reservoir to the FULL mark on the dipstick.

4. CONTROL VALVE AND STEERING GEAR

A. Removal

1. Disconnect the battery ground cable from the battery, Figure 15.

2. Remove the steering wheel retaining nut and washer. Remove the steering wheel with a steering wheel puller or other suitable tool.

3. Remove the spring, felt packing, and spring seat from the top of the steering column.

4. Disconnect the throttle rod link from the throttle arm and the throttle lever from the throttle lever bracket, Figure 16.

5. Disconnect the throttle lever from the throttle arm and remove the lever.

6. Disconnect the P.T.O. handle from the hood side panel. Drive the pin out, remove the nut, and detach the rod assembly from the panel.

NOTE: ***This applies only to Select-O-Speed models.***

7. Remove the hood side panels.

8. Disconnect the Proof-Meter cable at the instrument panel.

9. Disconnect the selector assembly (Select-O-Speed models only).
    a. Loosen the nut securing the selector cable to the transmission cover.
    b. Remove the four Phillips head screws attaching the selector assembly to the hood.
    c. Move the selector lever upward to the tenth

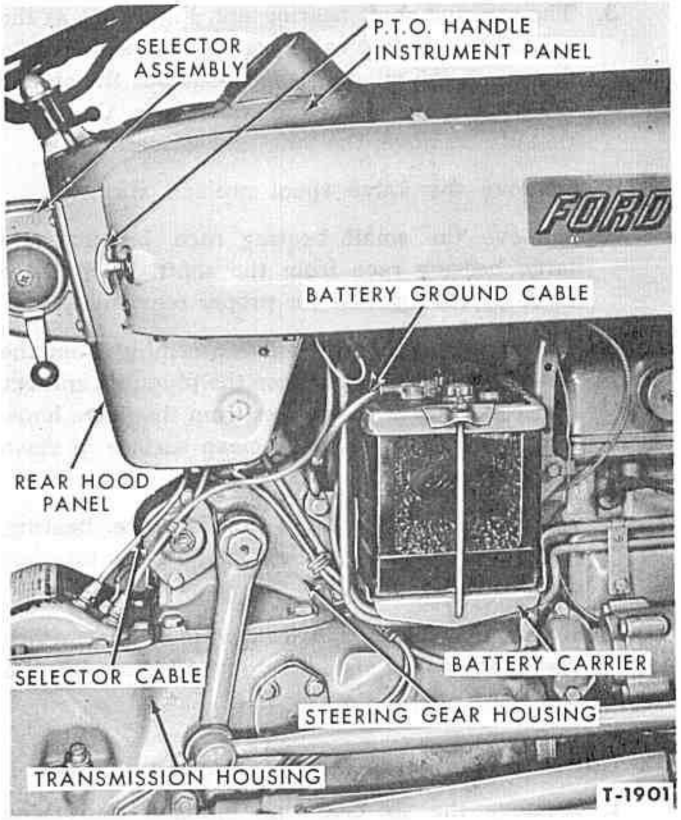

Figure 15—Installed View of Steering Gear Housing

speed position and disconnect the upward selector cable from the lower cable.

d. Disconnect the wires to the safety switch and the selector lamp. Disconnect the transmission oil warning lamp cable.

10. Detach the battery carrier from the steering gear housing.
11. Disconnect the ammeter or charge indicator light wire from the junction box, Figure 17.
12. Disconnect the generator regulator from the mounting pad on the steering column.
13. Disconnect the junction block from the mounting pad on the steering column.
14. Remove the temperature and the oil pressure gauge lines from the clip on the fuel tank rear support.
15. Disconnect the instrument panel from the lower rear hood panel. Slide the instrument panel over the top of the steering housing and set it on the fuel tank.
16. Disconnect the headlight switch from the lower rear hood panel.
17. Disconnect the lower rear hood panel from the steering gear housing. Remove the panel.
18. Disconnect the taillight wire from the clip on the steering gear housing.
19. Disconnect the hydraulic lines from the control valve, pump, and power cylinders. Seal all the exposed openings to prevent entry of dirt.
20. Remove the cotter pin and the castellated nut

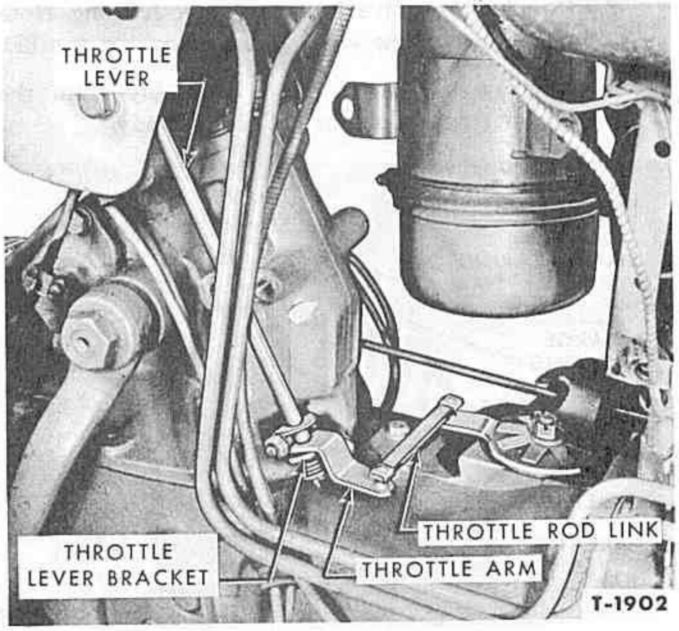

Figure 16—Throttle Linkage Installation

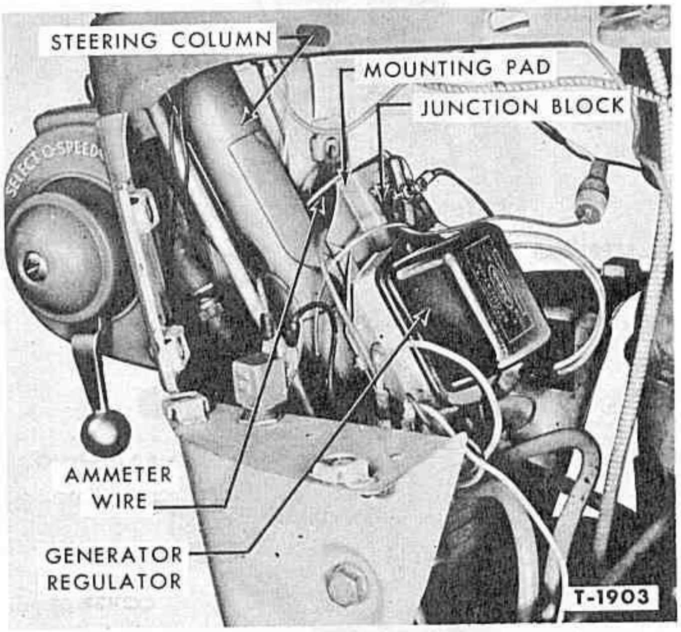

Figure 17—Installed View of Steering Column with Hood Side Panel Removed

from the drag links–Pitman arm connections and disconnect the Pitman arm using a puller.

21. Remove the bolts that attach the steering gear housing to the transmission case. Lift the steering gear and the control valve assembly out and place it on a bench.

B. Disassembly of Steering Column Components

1. Scribe an alignment mark on the valve cover, valve body, valve adapter, and the steering gear housing to insure proper reassembly, Figure 18.
2. Remove the bolts attaching the valve cover to the valve body. Lift the cover and integral tube assembly from the steering shaft.

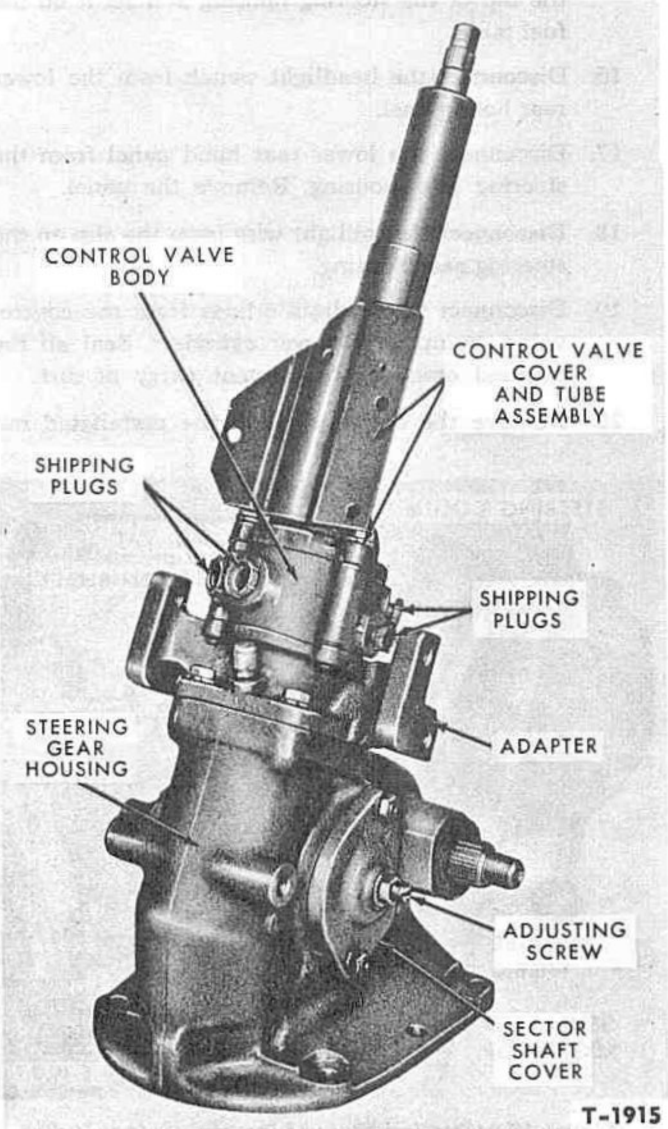

Figure 18—Steering Gear and Control Valve

3. The steering shaft bearing nut, Figure 19, at the top of the control valve assembly is staked to a groove in the steering shaft. Cut out the staked area carefully to avoid damaging the shaft threads, remove the nut and discard it.
4. Remove the valve spool preload spring.
5. Remove the small bearing race, bearing, and large bearing race from the shaft. Keep these three pieces together for proper reassembly.
6. Lift the entire control valve assembly from the shaft. Be careful not to lose the plungers, springs, and check valve assemblies from the valve housing. Place the parts on a clean surface in clean surroundings.
7. Remove the lower large bearing race, bearing, and small bearing race. Keep the parts together for proper reassembly.
8. Remove the bolts and lock washers that attach the adapter to the steering gear housing. Lift the adapter from the steering shaft.

C. Control Valve Disassembly and Inspection

1. Remove the six centering plungers and three centering springs from their bores, Figure 20.
2. Remove the two anti-cavitation plunger assemblies from their bores. Be careful not to lose the steel balls from each assembly. To insure proper assembly, note from which bores the assemblies were removed.
3. Remove the valve from the valve housing. Note which end of the valve has a groove on the I.D.
4. Unscrew the check valve assembly from the pump return port in the valve body.

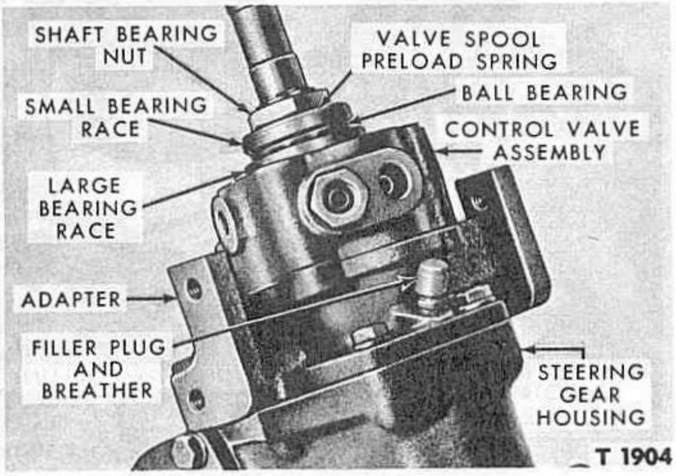

Figure 19—Steering Gear and Control Valve Assembly With Valve Cover and Integral Tube Assembly Removed

or equivalent and install, lip side in, with a socket of comparable size. Be careful not to damage the seal lip.

2. Replace the "O" ring on the face of the cover and tube casting and on the face of the adapter casting.
3. Inspect the needle bearing in the bottom of the adapter, Figure 22. The bearing rollers should be smooth, highly polished, and should turn freely. If it is necessary to replace a bearing, use Pilot Bearing Puller 956-2. The new bearing, with the trademark side out, should be pressed in just far enough for the bearing face to clear the casting surface.

   NOTE: ***Do not press bearing in so far that it contacts casting shoulder.***

F. Steering Gear Disassembly

1. Drain the oil from the steering gear housing.
2. Mount the assembly in a vise and, using a puller, remove the Pitman arms. Remove the felt seal from each end of the sector shaft.
3. Remove the bolts and lock washers from the right sector shaft cover and remove the cover and the sector shaft. Turn the adjusting screw clockwise until the sector shaft is free from cover, Figure 18.
4. Remove the left sector shaft in the same manner.
5. Lift the steering shaft and the ball nut assembly from the housing.

G. Steering Gear Cleaning, Inspection, and Repair

1. Remove the seals from the sector shaft bores in the steering gear housing.
2. Inspect the needle bearing in the bottom of the steering gear housing for wear or damage. Bearing rollers should be smooth, highly polished, and should turn freely. To replace, remove the old bearing with Pilot Bearing Puller 956-2 and 955-14 jaws.
3. Install a new needle bearing with trademark side up. Press the bearing into place until it is just below the chamfer in the bore.

   NOTE: ***Do not press bearing in so far that it contacts casting shoulder.***

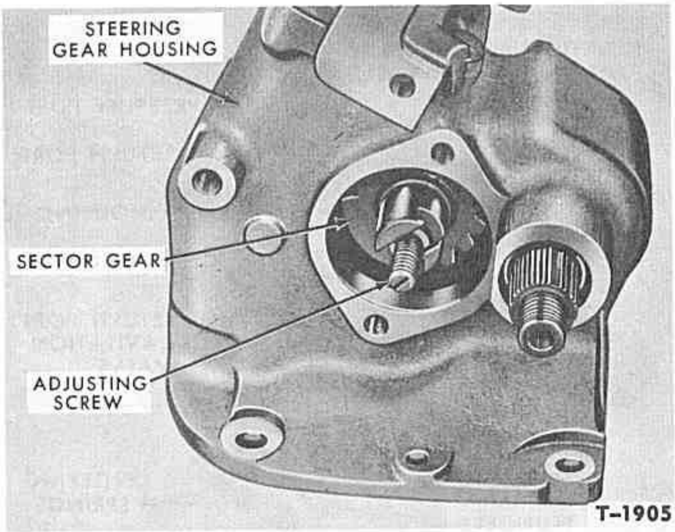

Figure 23—Steering Gear Housing with Sector Shaft Cover Removed

4. Inspect the steering gear housing and adapter mounting pad for cracks or other damage. Replace if damaged.
5. Examine the sector shaft bushings in both the steering gear housing and in the side covers. Replace if damaged or excessively worn. Use a puller to remove.

   NOTE: ***Do not drive bushings out with a punch. Use a press to install.***

   a. Press bushings flush to 0.03″ below large counterbore in housing.

   b. Install bushing 0.03″ below *inner* face of *cover.*
6. Replace the sector shaft seals in the steering gear housing.
7. Inspect the sector shafts and the gear teeth for signs of wear. Replace if necessary.
8. Examine the steering shaft and ball nut rack teeth. Replace the shaft and ball nut assembly, if necessary.

H. Steering Gear Assembly

NOTE: ***Coat all shafts and bushings with M-4738 lubricant before assembly.***

1. Install new "O" ring seals on the sector shaft side covers.
2. Use shim No. 8N-33544 A-B-C or D, on sector shaft adjusting screw to provide a clearance of 0.000 to 0.002 inch between the screw head and the shaft end inside the T-slot, Figure 23.

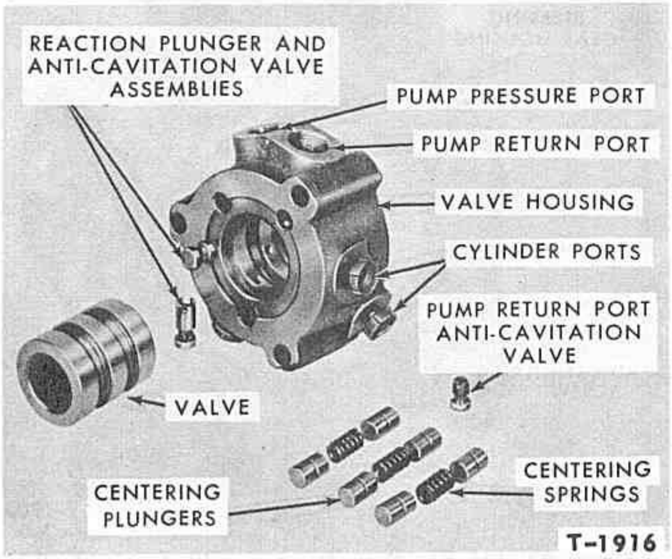

Figure 20—Control Valve—Disassembled View

5. Inspect the brass tubing seats in the valve body ports for damage. Replace if necessary.

6. Inspect the valve and valve housing bore for damage. If either part is damaged, they must be replaced as an assembly.

7. Inspect the centering plungers and springs for wear, damage, or distortion. Replace if defective.

8. Inspect the check valve and the two anti-cavitation valves, springs, and balls for defects that would cause improper operation. Replace if defective.

9. Examine the thrust bearings and their races for damage or wear. Replace if defective.

D. Control Valve Assembly

1. Coat the control valve, plungers, and anti-cavitation valves with Lubriplate or equivalent.

2. Install the valve in the valve body. Groove on I.D. of valve should be at the same end in relation to valve body as was noted upon removal. DO NOT FORCE VALVE. When properly aligned, it will drop into place.

3. Install the check valve in the pump return port of the control valve housing.

4. Insert the spring, then the ball, in both the anti-cavitation valves and install the valve assemblies in their bores.

5. Install a centering spring in each of the three remaining bores.

6. Install a centering plunger at each end of the three centering springs.

E. Seal Inspection and Replacement in Adapter and Cover

1. Inspect the seal in the bore of the control valve cover and integral tube assembly, Figure 21, and in the bore of the adapter assembly, Figure 22, for damage or hardening of the seal lip. Replace if necessary. Coat the new seal with Lubriplate

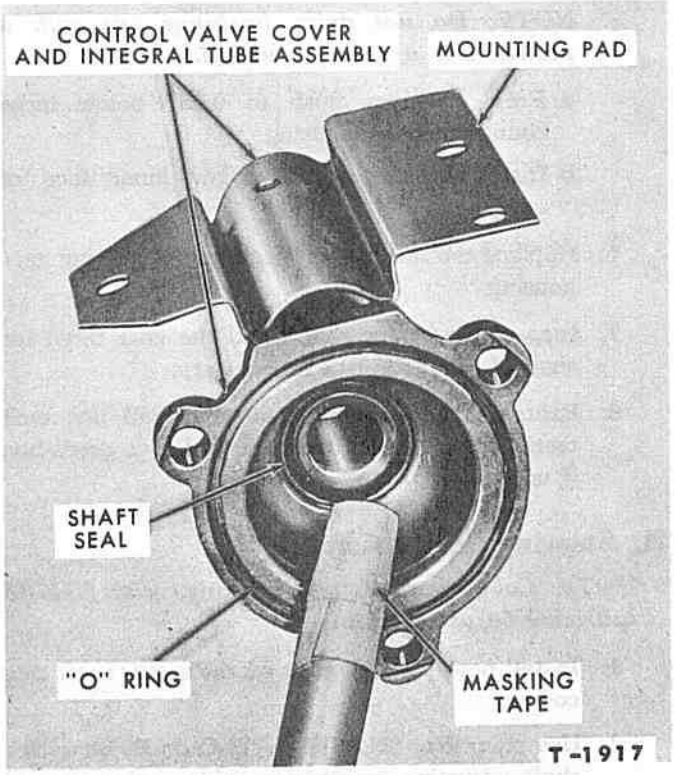

Figure 21—Installing the Control Valve Cover and Integral Tube

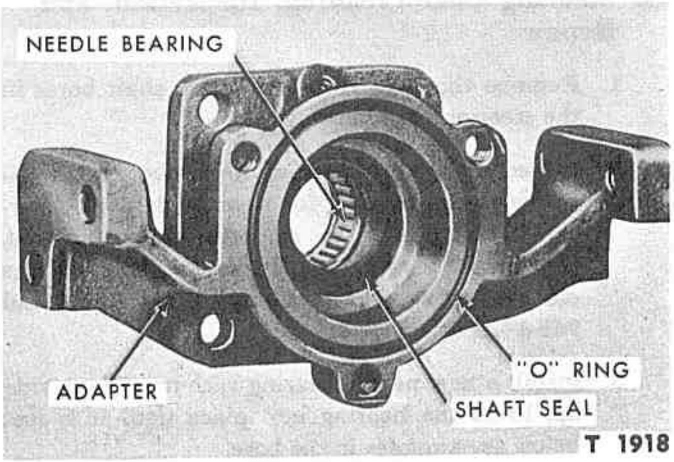

Figure 22—Adapter Assembly—Showing Bearing and Seal

3. Use the adjusting screw in each side cover as a screw jack to pull the sector shafts into the side covers.

4. Center the ball nut assembly on the steering shaft and insert the shaft into the needle bearing at the bottom of the steering gear housing. If the ball nut is centered properly, an equal amount of the worm will show on each side of the ball nut.

5. Install the left sector shaft (shaft with block tooth) and side cover. Make sure the ball nut is centered as described in Step 4. With the block tooth in the upper-most position, the middle tooth must mate with the middle groove in the ball nut rack. Install the cover bolts and lock washers tightened to 25-30 ft. lbs. torque.

6. Install the right sector shaft so that the fourth tooth meshes with the fourth groove on the left sector shaft.

7. Place the felt seals over the ends of both sector shafts and install the Pitman arms, lock washers, and nuts.

I. Assembly of Steering Gear Components

1. Position a new gasket and mount the adapter on the steering gear housing so that the filler plug is at the front. Be careful not to damage the seal in the adapter when the shaft is inserted. Attach the adapter to the housing with the bolts and lock washers. Tighten the bolts to 20-25 ft. lbs. torque.

2. Install the control valve assembly on the adapter as follows:

   a. Assemble the ball bearing between the two bearing races with the small race on bottom.

   b. Place this bearing against the bottom of the control valve assembly so that the large race holds the centering plungers in position.

   NOTE: ***Top side of valve is indicated when embossed markings on the valve ports are up.***

   c. Holding the bearing assembly tight against the bottom of the control valve, carefully lower both assemblies over the steering shaft into position on the adapter.

   d. Locate the valve so that the two pump ports are positioned just to the right of the center facing front.

   e. Install the other bearing with the large race at the bottom next to the valve.

3. Install the preload spring, convex side up, at the top of the valve assembly.

4. Install a new bearing lock nut on the threaded portion of the steering shaft.

5. Temporarily install three hex bolts that attach the valve and cover and tube to the adapter.

6. Temporarily install the steering wheel.

7. Hold the steering wheel to prevent the shaft from turning and tighten the lock nut until the large bearing race seats firmly against the valve spool. Back the nut off about ⅙ turn and stake the nut to the groove in the shaft. Use a support to avoid bending the shaft.

8. Remove the steering wheel and the three cover-to-valve-to-adapter bolts.

9. Tape the splined end of the steering shaft, Figure 21, and sharp shoulder to prevent damage to the control valve cover seal during installation of cover.

10. Install control valve cover and tube over the shaft, with the mounting pad on tube, facing forward. Coat cover housing with M-4738 lubricant before installation on shaft. Also, be sure that cover-to-adapter "O" ring is in place.

11. Attach the control valve cover and the control valve to the adapter with three bolts and lock washers. Tighten the bolts to 20 ft. lbs. maximum torque.

12. Adjust the sector shaft as follows:

    a. Loosen the left sector shaft adjusting screw, then turn the screw several turns counterclockwise.

    b. Loosen the right adjusting screw lock nut. Turn the adjusting screw clockwise until there is no perceptible end play in the sector shaft. Tighten the lock nut securely without disturbing the end play.

    c. Turn the left sector shaft adjusting screw clockwise until there is no perceptible end play in the left sector shaft. Tighten the lock nut securely without disturbing the end play.

    d. Turn the steering wheel full left and full right and determine the center point where the steering gear is in the straight-ahead position.

At this position, the Pitman arms should have no perceptible free play. Readjust if necessary. Total pull at rim of steering wheel with gear over center, must be 2 to 2.5 lbs. when properly adjusted.

J. Installation of Control Valve and Steering Gear

1. Mount the steering gear on the transmission case and secure with the hex head bolts tightened to 60-70 ft. lbs. torque. Then fill the steering gear housing with M-4T38 Lubricant.
2. Attach the drag link to the Pitman arm with the castellated nut and the cotter pin.
3. Position the battery carrier to the steering gear housing and attach the Proof-Meter cable clip to the carrier. Then install the two hex head bolts and lock washers which secure the carrier to the steering gear housing.
4. Connect the hydraulic lines from the cylinder and the power steering pump.
5. Insert the taillight wire into the clip on the steering gear housing.
6. Place the hood lower rear panel in its installed position and secure it to steering gear housing with the two hex head bolts, flat washers, and lock washers. Tighten the bolts securely.
7. Install the headlamp switch on the lower rear panel.
8. Secure the generator regulator to the steering column mounting pad with the attaching screws.
9. Secure the junction block to the mounting pad on the steering column.
10. Position the instrument panel over the steering shaft and secure it to the lower hood panel.
11. Insert the temperature gauge and the oil pressure gauge lines into the clip on the fuel tank support.
12. Attach the ammeter or charge indicator light wire to the junction block.
13. Attach the battery ground cable to the positive terminal on the battery.
14. Connect the Proof-Meter cable to the Proof-Meter.
15. Position the throttle lever through the instrument panel, throttle lever arm, a flat washer, and throttle lever bracket. Slide the spring over the bottom of the throttle lever and secure with a flat washer and a cotter pin.
16. Tighten the bolt and nut that secures the throttle lever arm to the throttle lever.
17. Attach the throttle lever arm link to the throttle lever arm and to the bell crank.
18. Install the spring seat, felt packing, and spring on the top of the steering shaft.
19. Position the steering wheel on the shaft so that one spoke is pointed forward when the wheels are in the straight-ahead position. Then, install the power steering emblem and nut. Tighten the nut securely.
20. Install the selector assembly.

    NOTE: ***This applies only to Select-O-Speed models.***

    a. Move the selector lever to the tenth speed position.
    b. Attach the wires to the safety switch and the selector lamp and attach the two flexible cables together.
    c. Move the selector lever to the (P) park position. This should bring the selector cable down to contact the fitting in the transmission.
    d. Attach the selector assembly to the hood with the four Phillips head screws.
    e. Tighten the lower conduit nut on cover fitting.
21. Fill the steering gear housing to plug level. Use extreme pressure lubricant SAE 90 in summer—SAE 80 in winter. Install the filler plug and breather assembly, Figure 19.
22. Before installing the hood side panel, check the hydraulic line connections for leaks. Connect the transmission oil pressure warning lamp cable *before* running engine to check power steering. Operate the power steering system as outlined in Steps 7 and 8 on Page 292.
23. Install the hood side panel.
24. Position the P.T.O. rod assembly through the side panel, and install the nut. Place the handle on the rod and secure with the roll pin. (Select-O-Speed models only.)

5. POWER CYLINDER

NOTE: ***There is a right and a left power cylinder. To insure proper installation, make sure that each cylinder is identified.***

A. Removal

1. Place a drain pan under the rear of the cylinder and disconnect both hydraulic lines, Figure 1.
2. Remove the nut that secures the cylinder to the drag link. Disconnect the cylinder from the drag link with a suitable puller.
3. Remove the nut from the rear of the cylinder and disconnect the cylinder from the radius rod.
4. Move the rod back and forth slowly to drain the oil from cylinder through the cylinder ports.

B. Disassembly

1. Remove the drag link end from the piston rod.
2. Use snap ring pliers to remove the snap ring from the piston rod end of the cylinder, Figure 24.
3. Extend the rod to the end of its travel and remove the metal scraper washer, leather wiper, and aluminum bushing from the rod.
4. Remove the seal. The piston rod will usually loosen the seal from its seat. If not, use a sharp pointed tool to pry it out.

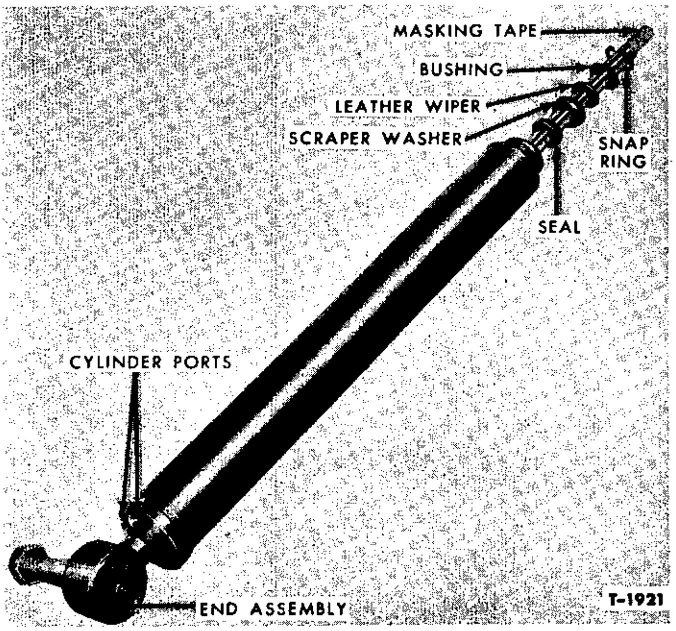

Figure 24—Power Cylinder Assembly

C. Cleaning, Inspection, and Repair

1. Use a solvent to clean the cylinder and piston rod.
2. Inspect the cylinder for leakage at the seams and the cylinder ports for damage to the threads. If the ports are damaged, insert an E-Z-Out into the seat and remove both the E-Z-Out and the seat with pliers.
3. Position a new seat squarely in its bore and thread the existing fitting into the port until the seat is firmly in place.
4. Inspect the piston rod for being bent or scored. Replace the power cylinder if piston rod is damaged.
5. Check both end assemblies for thread damage. Make sure the flexible joint moves freely. If the rear ball joint is worn or damaged, replace the power cylinder.

D. Assembly

1. Soak the seal and the leather wiper in Ford M2C41 Hydraulic Oil.
2. Mask the threaded end of the piston rod. Carefully install the seal on the rod with the seal lip facing the rear of the cylinder.
3. Press the seal into its seat using a deep socket. The seal has an 0.010 inch I.D. interference fit and care must be used to press the seal in straight.
4. Install the bushing, wiper, and metal scraper washer. The raised center portion of the scraper washer must face out.
5. Install the snap ring with the sharp edge out.
6. Remove the masking tape and install the drag link end on the piston rod.

E. Installation

1. Install the rear ball joint stud in the radius rod mounting pad. Secure with a $\frac{9}{16}$"-18 hex nut and torque to 90-110 ft. lbs.
2. Install the drag link end in the drag link mounting pad. Secure with $\frac{1}{2}$"-20 hex nut and torque to 75-90 ft. lbs.
3. Connect the hydraulic tubing to the cylinder ports.

6. TROUBLE SHOOTING

See Chapter 1-C Page 338.

7. SPECIFICATIONS

Pump—Used in early model "General Purpose" Tractors

Capacity	6.50 gpm @ 3000 rpm and 100 psi
Type	Sleeve
Drive	Belt
Maximum Operating Pressure	700-800 psi

Cylinder

Type	Double Acting

Torque Limits	Ft. lbs.
Sector Shaft Cover Bolts	25-30
Adapter to Steering Gear Housing	20-25
Steering Gear Housing to Transmission	60-70
Steering Shaft Cover and Valve Housing Assemblies to Adapter	20
Sleeve Type Pump End Cap and Bearing Cap to Pump Body Bolts	15-20

8. SPECIAL TOOLS

The following tools will be helpful in removing, repairing or servicing the various components of the power steering mechanism.

Tool Number	Description
956	Puller Bearing
955-14	Jaws (for 956 Puller)—Bearing
N3 10776	Fixture Cylinder Block
▲▲	Snap Ring Pliers

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS, AND TIRES

Chapter

1-B

Power Steering—Row Crop Tractors

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3	Power Steering Pump–Rotor Type	307
4	Steering Gear	311
5	Power Cylinder and Control Valve Assembly	316
6	Trouble Shooting	322
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1. CONSTRUCTION AND OPERATION

Power steering information on this page through page 322, is applicable to all "Row Crop" tractors. For power steering information on other models, see pages 282 to 300 ("General Purpose" tractors) or pages 323 to 340 ("Industrial Tractors").

All units that affect the directional control of the tractor are components of the steering mechanism. These units are: the steering gear (including the steering column and steering wheel), the drag link, oil pump and reservoir, power cylinder and control valve, and the steering arm, Figure 1.

The system employs the conventional Ford Tractor mechanical steering gear and linkage plus a hydraulic oil pump, and a power cylinder and control valve to provide a power assist in all steering operations.

In the event of failure of the power assist components, the mechanical gear and linkage will provide positive steering control at all times.

A. Drag Link

The drag link, Figure 1, consists of the drag link and the drag link adjusting sleeve. It is the steering linkage between the Pitman arm, attached to the steering gear, and the steering arm, Figure 2, connected to the front spindle assembly. "Row Crop" tractors have one drag link. It is mounted on the right side of the tractor. The drag link has no moving parts and requires little maintenance. Whenever it becomes necessary to change the length of the drag link, as in the case of a position adjustment of the front axle, care must be exercised to avoid changing the position of the steering arm. See page 307 in this section for details.

B. Power Steering Pump

Rotor-Type: Early model "Row Crop" tractors are equipped with a rotor-type pump and reservoir, mounted at the front right side of the engine, Figure 2. The pump is driven from the engine crankshaft by a single V-belt. Two elongated holes in the pump support bracket provide a means for adjusting the belt tension.

The pump consists of a six-lobed drive rotor and a seven-lobed driven rotor mounted in a cast iron body, Figure 3.

The drive rotor which is keyed to the pump drive shaft has external lobes or teeth which are meshed with the internal lobes of the driven rotor. The drive shaft is supported at the pulley end by a sealed ball bearing, Figure 9. The bearing, which is a slip fit in the pump body, is held in place by a snap ring. A lip-type, spring-loaded oil seal is installed behind the bearing. The center and the inner end of the drive shaft are supported by bronze bushings pressed into the pump body and the pump cover.

As the pump rotors turn, the clearance volume of the pockets formed between the lobes increases, then

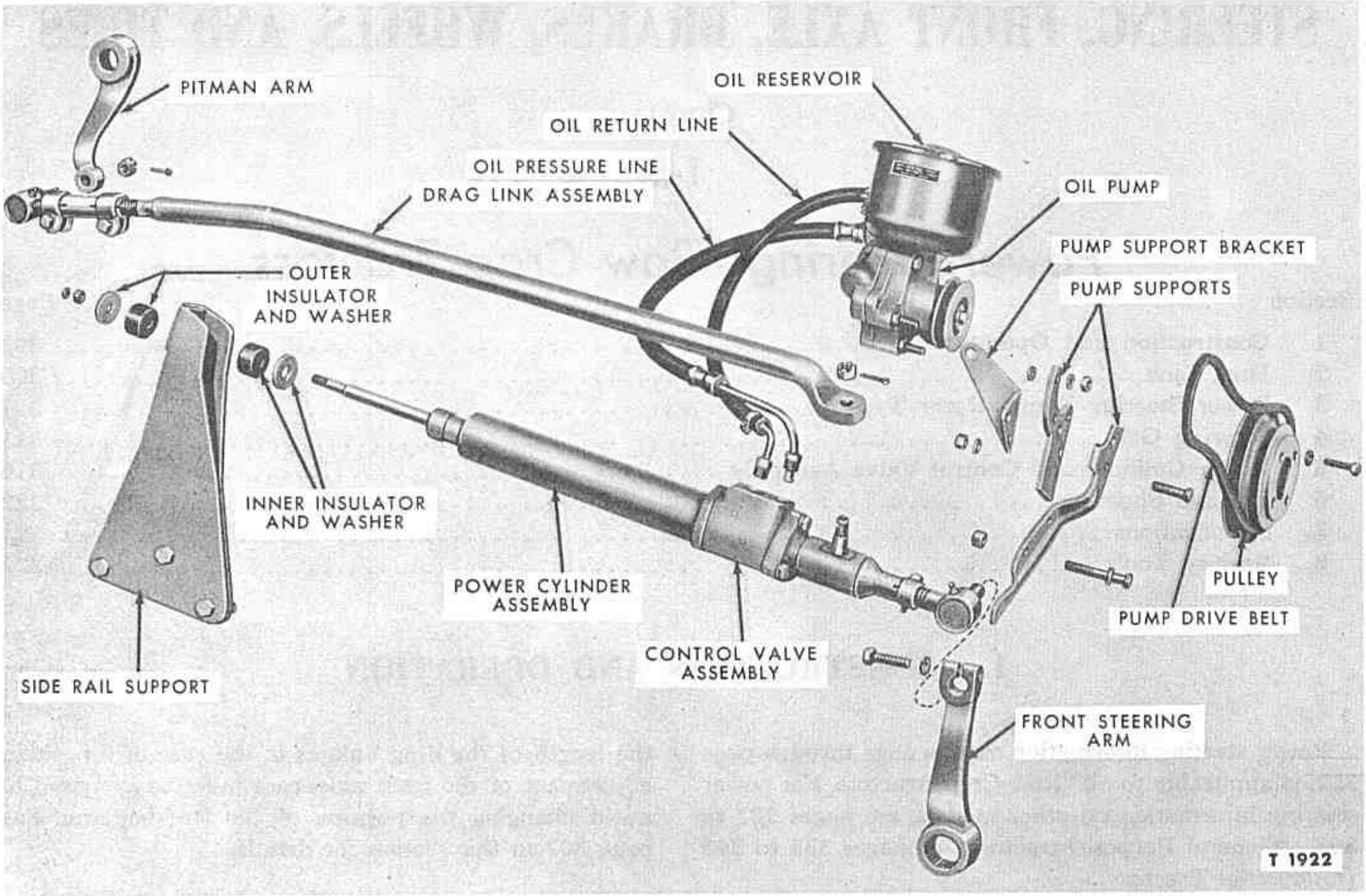

Figure 1—Components of Power Steering System

decreases. This action propels oil from the suction (intake) side to the discharge side of the pump.

Minimum output of the pump occurs when the engine is at idle speed. This minimum output is sufficient to provide a power assist for turning.

Maximum output of the pump, at higher engine speeds, is limited to 2.75 gallons per minute by a spool-type, spring-loaded flow control valve, mounted in the pump cover, Figure 4. It is held in place by a fitting which is sealed with a neoprene "O" ring. The valve, which is hollow and closed at one end, has two small metering orifices in its wall, 180° apart.

Mounted inside the flow control valve is a spring-loaded pressure relief valve, Figure 4. The relief valve and relief valve spring are held in place by a snap ring. An orifice plate, with a small metering hole in its center, is installed between the flow control valve spring and the pressure relief valve snap ring.

When the system is operating, oil from the pressure side of the pump flows into the chamber containing the flow control valve. A flat, ground on the land at the closed end of the valve allows the oil to flow behind the closed end of the valve. Oil also flows to the inside of the valve through the two metering holes in the valve wall. From here the oil flows through the pressure relief valve and orifice plate and out through the pump discharge to the control valve.

When pump speed is increased (by increasing engine speed), pump output tends to exceed a maximum of 2.75 gallons per minute. This creates a pressure differential between the outside and the inside of the flow control valve, due to the flow of oil through the metering orifices. This causes the flow control valve to move back against the flow control valve spring and allow excess oil to be by-passed within the pump.

The oil pressure relief valve, mounted inside the flow control valve, is designed to limit pump pressure to 1100 psi. The valve operates as follows:

When pump pressure tends to exceed 1100 psi, the force of the relief valve spring is overcome and pressure against the face, at the orifice plate end, moves the relief valve to the right. This movement uncovers ports in the flow control valve and permits the oil to return to the intake side of the pump, thus preventing a pressure build-up in excess of 1100 psi. The relief

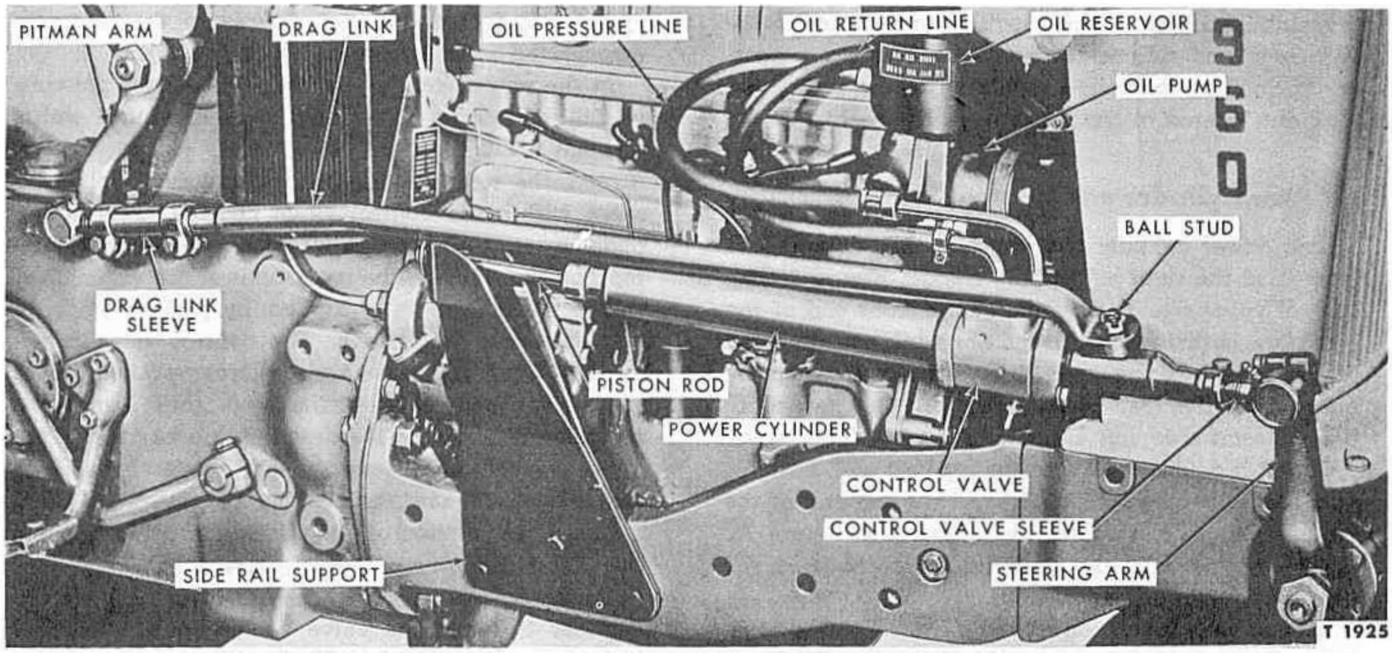

Figure 2—Installed View of Power Steering System Components

action of the relief valve takes place regardless of the position of the flow control valve, since the flow control valve regulates only the volume of oil exhausted from the pump.

Roller Vane-Type: Late model "Row Crop" tractors use a roller vane-type pump. The operation of this pump is described in Chapter 1-C.

C. Steering Gear

All "Row Crop" tractors use a worm and sector-type steering gear, Figure 17. The worm, which is integral with the steering shaft, transmits motion through the sector and sector shaft, to the Pitman arm and the drag link which is connected to the front steering arm. Only one sector shaft is used and all steering is controlled from one steering arm mounted on the right side of the tractor.

The backlash between the worm gear and the sector gear must be properly adjusted so that the gears do not bind. This adjustment is made by turning an eccentric sleeve in which the worm gear rides.

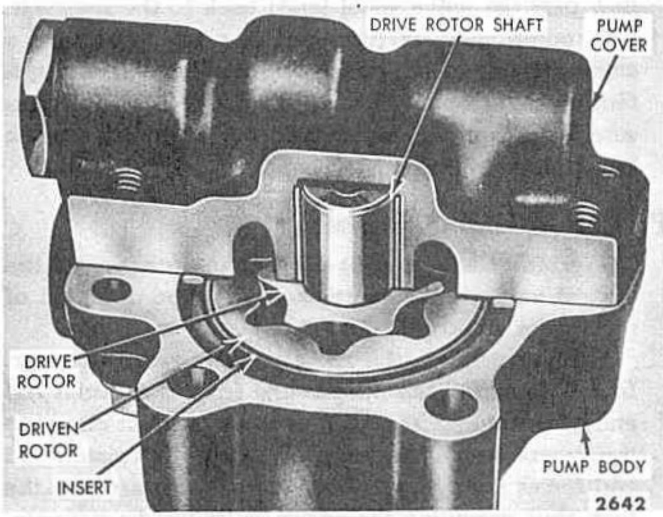

Figure 3—Cutaway View of Rotor-Type Oil Pump

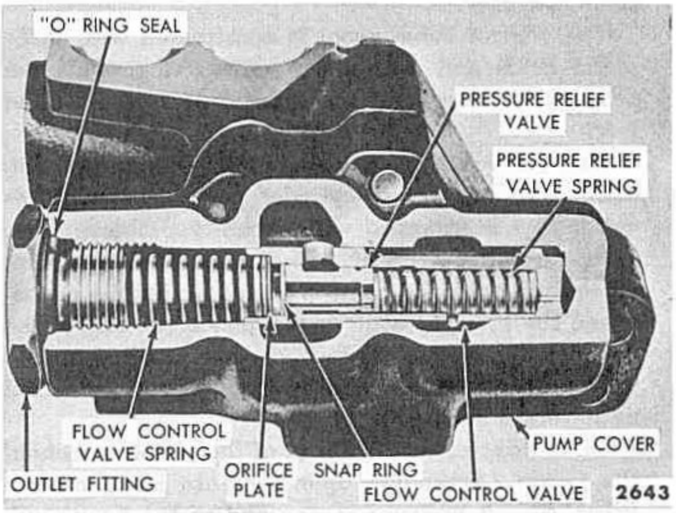

Figure 4—Cutaway View of Pump Flow Control Valve

Turning the sleeve moves the worm gear in or out in relation to the sector gear. Position of the sleeve is maintained by a rotating lock plate mounted in the end cover and splined to the sleeve. The worm bearing preload is controlled by an adjusting screw and lock nut located in the end cover, Figure 23.

D. Power Cylinder and Control Valve Assembly

The power cylinder and control valve assembly is located at the right side of the tractor, Figure 2. The control valve sleeve, which is at the front end of the assembly, is threaded onto the drag link and attached to the front steering arm. The piston rod, which extends from the rear of the assembly, is attached to the pedestal side rail support, Figure 2. The power cylinder is double-walled. A lip-type oil seal, bushing, dust seal, and scraper, installed in the rod end of the cylinder, are held in place by a snap ring, Figure 25. The piston end of the cylinder is attached to the control valve housing.

The control valve consists of a control valve housing, a sleeve and flange assembly bolted to the housing, and the internal parts shown in Figure 25.

The control valve ball stud, spring, retainer, and spring stop plug are installed in the sleeve and flange assembly. The parts are held in place by a control valve spool stop screw which threads into the end of the ball stud retainer.

The control valve spool, seals, and retainers, mounted in the valve housing, are held in position by a long bolt which passes through the valve spool. The bolt is connected to the ball stud retainer by a spring, stop plug, and stop screw, Figure 27. A stop pin, inserted through the stop screw and the bolt head, prevents the bolt from rotating. A self-locking nut secures the bolt to the outer end of the valve spool assembly.

The control valve spool is constructed with three radial lands and four radial valleys to provide the passages necessary for the directional control of the fluid.

The control valve housing incorporates an inlet, outlet, and two power cylinder ports. The reservoir outlet port is equipped with a ball-type check valve.

In the power cylinder, one of the two oil passages, connecting with the control valve, carries the oil between the cylinder walls to the piston rod end of the cylinder. The other passage carries oil directly into the piston end of the cylinder. Both passages are used as oil return lines.

Oil is directed either ahead of the piston or behind the piston (depending upon the turn being made). When the oil pressure at one end of the power cylinder becomes great enough, the cylinder moves on the piston rod to provide the power assist. As the cylinder moves, the oil at the opposite end of the cylinder is forced out and returns to the reservoir through the control valve.

In the power steering operation, oil under pressure is delivered from the pump to the control valve through a flexible hose. When the steering wheel is turned, the steering linkage moves the control valve spool within the control valve housing. This action opens a series of passages which direct the oil flow to the power cylinder. The movement of the valve spool within the housing is controlled, by positive stops, to approximately 0.060 inch. The control valve is designed so that the power assist is accomplished before the valve spool reaches the stop, thus insuring a sensitive response. As the drag link moves further, the entire control valve assembly and the steering spindle arm move as a unit, assisted by the power cylinder.

When the rotation of the steering wheel is stopped, the thrust against the control valve is removed. This permits the movement of the steering arm by the cylinder to move the valve housing until the spool is in its center position. Hydraulic pressure retains the spool in its center position by means of oil passages between two valleys in the valve spool and the chambers between the outer lands and the housing seals. If the ball stud is moved forward, the pressure in the chamber at the forward end of the spool increases in proportion to the pressure applied to the power cylinder. Thus, the hydraulic centering force provides a feel at the steering wheel which is proportional to the effort required to turn the front wheels.

E. Straight-Ahead Driving

In straight-ahead driving, the centered control valve spool, Figure 5, permits oil from the pump to flow past the valve spool lands back to the reservoir. The pump delivers just enough oil to overcome a small amount of back pressure that exists in the system under this condition. In the power cylinder, pressure is transmitted to both sides of the piston and a balanced condition exists.

F. Left or Right Turning

For either left or right turning, the function of the control valve is the same except for the direction of movement, Figures 6 and 7.

For left turning, the spool moves toward the rear. In this position, the oil passage from the piston rod end of the cylinder is open to the pump but closed to the reservoir. Oil under pressure at the piston rod end forces the cylinder (and the steering arm) to the rear, thus providing the power assist for the left turn. Simultaneously, the oil passage from the piston end

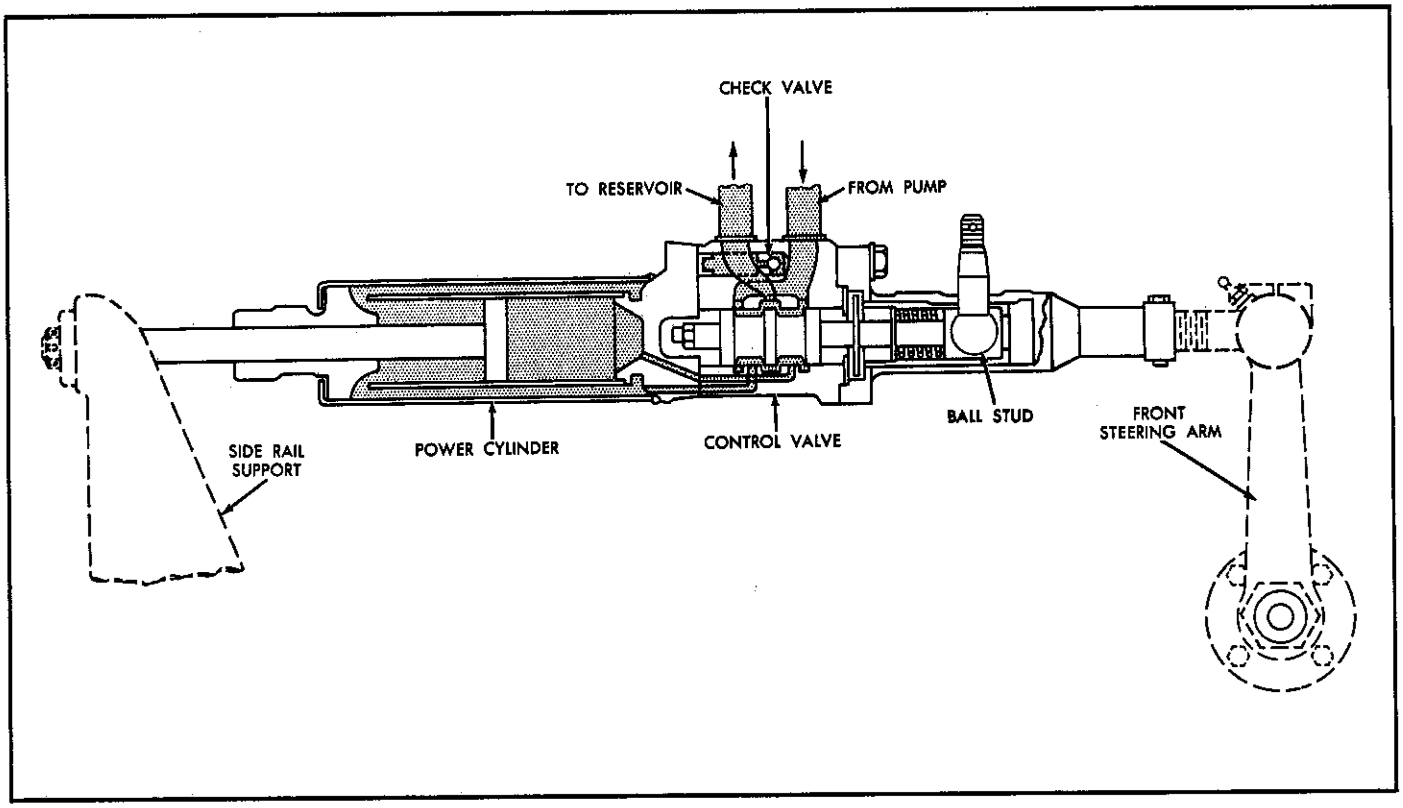

Figure 5—Flow Diagram—Oil Flow with Pump Flow Control Valve in Center Position

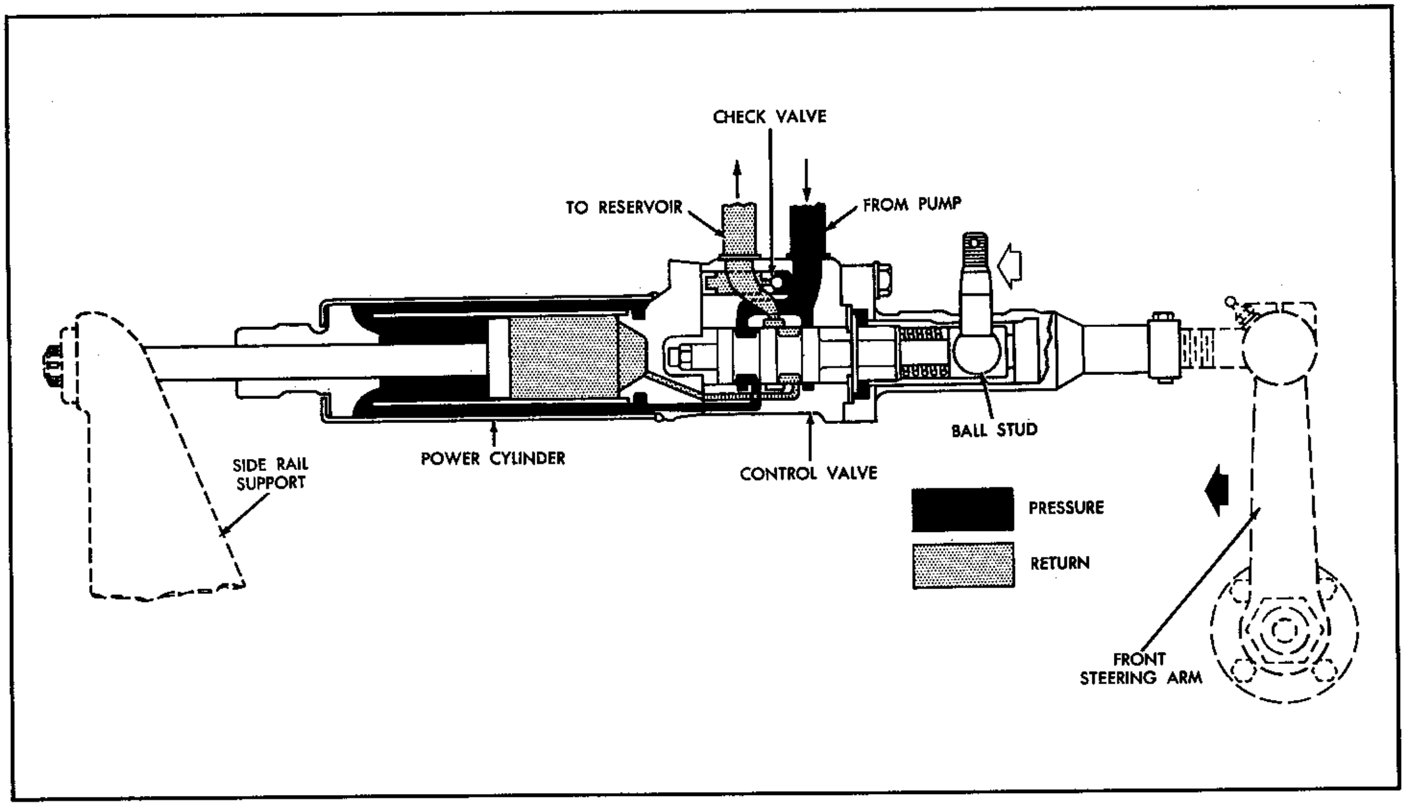

Figure 6—Flow Diagram—Oil Flow with Pump Flow Control Valve in Left Turn Position

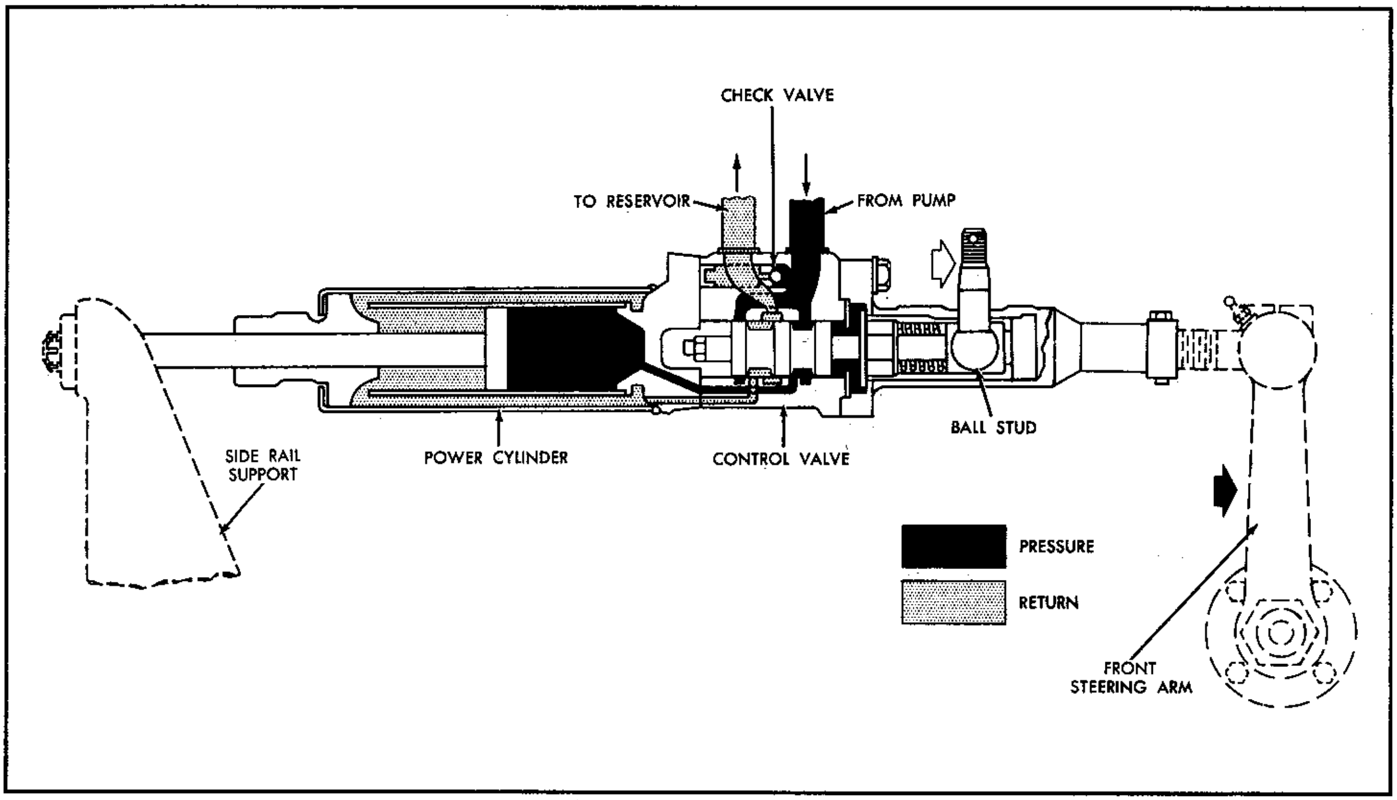

Figure 7—Flow Diagram—Oil Flow with Pump Flow Control Valve in Right Turn Position

of the cylinder is open to the reservoir but closed to the pump, permitting the oil to flow through the control valve to the reservoir.

In right turning, the spool moves toward the front. Oil under pressure is directed to the piston end of the cylinder moving the cylinder (and steering arm) forward. Simultaneously, oil from the piston rod end is returned to the reservoir.

G. Operation Without Pressure Supply

The steering mechanism is designed to operate manually if the pump fails to deliver oil under pressure. In this situation, steering wheel thrust is transmitted through the drag link to the control valve spool which moves approximately 0.060 inch before it contacts its stop. Then, the full manual effort is transmitted mechanically to the steering linkage. With the valve spool off its center position, oil is directed to either end of the power cylinder through the return port check valve. Thus, manual movement of the power cylinder is not restricted by the necessity of forcing oil back through the pump, and steering effort is not appreciably increased over that required for the manual steering system.

2. DRAG LINK

A. Removal

1. Remove the drag link by removing the cotter pins and the castellated nuts which attach it to the Pitman arm (rear) and to the control valve sleeve and flange assembly (front), Figures 1 and 2.
2. Remove the sleeve from the rear of the drag link by loosening the hex nuts and lock washers and threading the sleeve off of the drag link and the drag link end.

B. Inspection

1. Visibly inspect the parts for wear or damage. Replace the drag link if defective.

C. Installation

1. Thread the sleeve onto the drag link end and onto the drag link. Do not tighten the hex nuts.
2. Position the drag link to the ball stud on the control valve sleeve and flange and secure with the castellated nut and the cotter pin.
3. With the steering wheel and the front wheels in straight-ahead position, adjust the sleeve as necessary to position the drag link end to the Pitman arm. Secure with the castellated nut and the cotter pin.
4. Tighten the sleeve lock nuts.

3. POWER STEERING PUMP—ROTOR TYPE

A. Removal

NOTE: ***Complete instructions for overhauling the Roller Vane-type pump are given in Chapter 1-C of Part THREE.***

1. Remove the oil reservoir cover and withdraw as much oil as possible using a suction gun.
2. Disconnect the pressure line and the return line hoses from the oil pump, Figure 1. Fasten the hoses in a raised position to prevent oil drainage.
3. Remove the drive belt from the pump pulley by loosening the pump support bracket bolts.
4. Remove the pump support bracket bolts and lift the pump and the support bracket off as an assembly.

B. Disassembly

1. Drain the remaining oil from the pump, then seal the pressure and the return line ports to prevent dirt from entering. Clean the outside of the pump and the reservoir. Mount the assembly in a vise by clamping the support bracket.
2. Unhook the filter element retaining spring and lift the spring and filter element from the reservoir, Figure 8.
3. Remove the oil reservoir retaining bolt, then lift the filter element support plate, reinforcement plate and reservoir from the oil pump housing. Remove the pump intake and reservoir retaining bolt "O" rings from the pump housing.
4. Remove the bolt and the washers from the end of the pump shaft, then remove the pulley and Woodruff key.

   IMPORTANT: ***Do not hammer on the pump shaft to free the pulley.***

5. Loosen the two bolts and lock washers which secure the pump cover to the pump body.
6. Remove the three nuts, lock washers, and spacers that secure the pump support brackets to the pump body. Separate the pump from the brackets and remove the brackets from the vise.
7. Remove the two bolts and lock washers and the three mounting stud nuts that hold the cover to the pump body and separate the cover from the body.

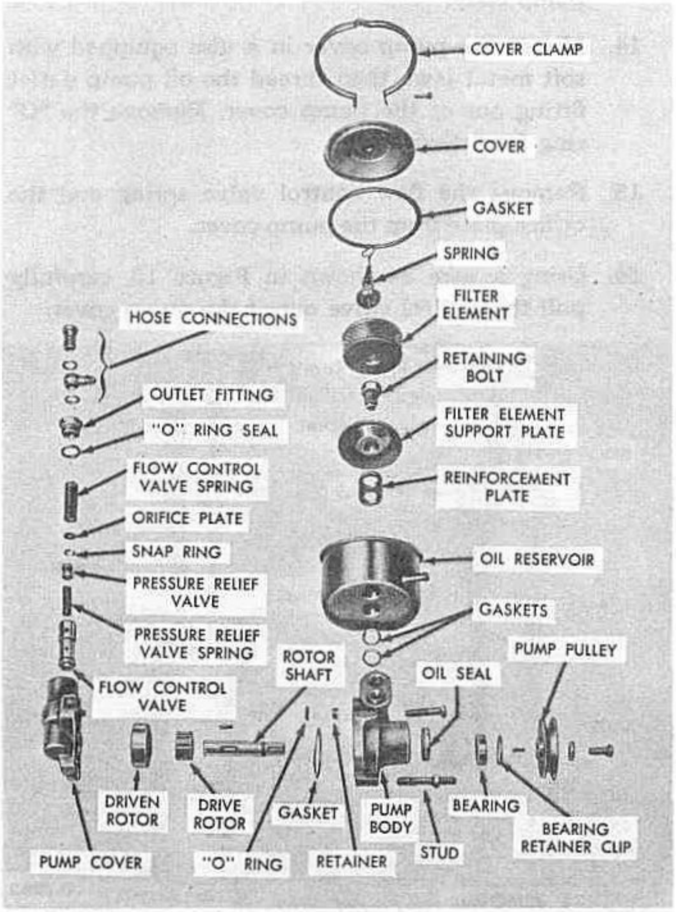

Figure 8—Rotor-Type Oil Pump—Disassembled

8. Remove the cover gasket from the groove in the body.

9. Lift the flow director "O" ring out of the bore in the pump body.

10. Remove the oil pump rotors and drive the key from the drive shaft.

    IMPORTANT: ***Handle the rotors, shaft, pump body, and cover carefully as nicks, burrs, cracks, or scratches may render them unfit for further service.***

11. Mount the pump body lightly in a vise with soft jaws, then remove the rotor shaft bearing retainer clip with a screwdriver.

12. Carefully Press or tap the rotor shaft and bearing from the pump body. Check both parts for excessive wear or other damage. If replacement is necessary, press the bearing off the shaft using an arbor press and an adapter which will bear against the bearing inner race, Figure 9.

13. Inspect the rotor shaft oil seal for wear or damage. If defective, use a punch to remove it from pump body.

14. Mount the pump cover in a vise equipped with soft metal jaws, then thread the oil pump outlet fitting out of the pump cover. Remove the "O" ring from the fitting.

15. Remove the flow control valve spring and the orifice plate from the pump cover.

16. Using a wire as shown in Figure 10, carefully pull the control valve out of the pump cover.

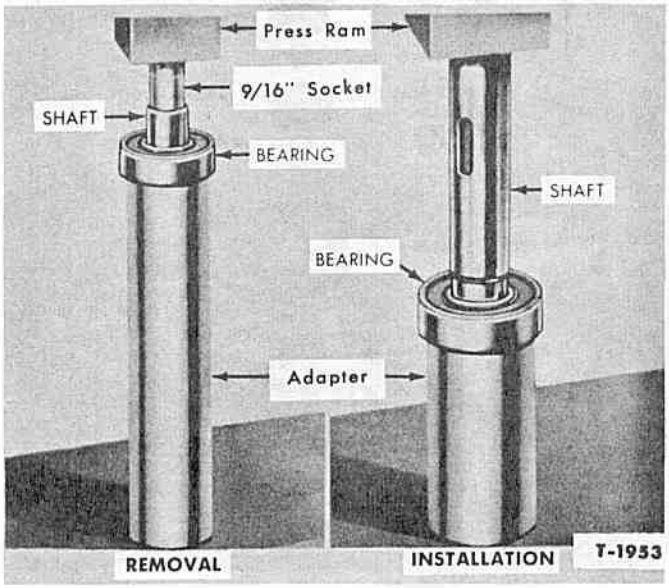

Figure 9—Rotor Shaft Bearing Replacement

17. Remove the snap ring that secures the pressure relief valve and spring in the flow control valve. Remove both the valve and the spring.

    IMPORTANT: ***Handle the valves carefully to prevent damage.***

C. Cleaning, Inspection and Repair

1. Wash all the parts except the rotor shaft bearing in a solvent. Air dry all parts.

2. Inspect the oil pump body and the cover for wear by the rotors. Check the bushings in the body and the cover for wear or scores. If the pump body or bushing is defective, replace both the pump body and the rotor sub-assembly. If the pump cover or bushing is defective, replace the pump cover.

3. Inspect both rotors for wear, cracks, or scores. If either rotor is defective, replace the entire assembly including the pump body. If the rotors are in good condition, proceed as follows:

    a. Tap the bearing assembly into the pump body until the bearing is seated in the body.

    NOTE: ***Apply pressure to the outer race of the bearing when installing it in the pump body.***

    b. Install the drive rotor and the driven rotor. Check the clearance between the rotors, at all points, with a feeler gauge as shown in Figure 11. If the clearance exceeds 0.006 inch, replace the pump body and rotor assembly.

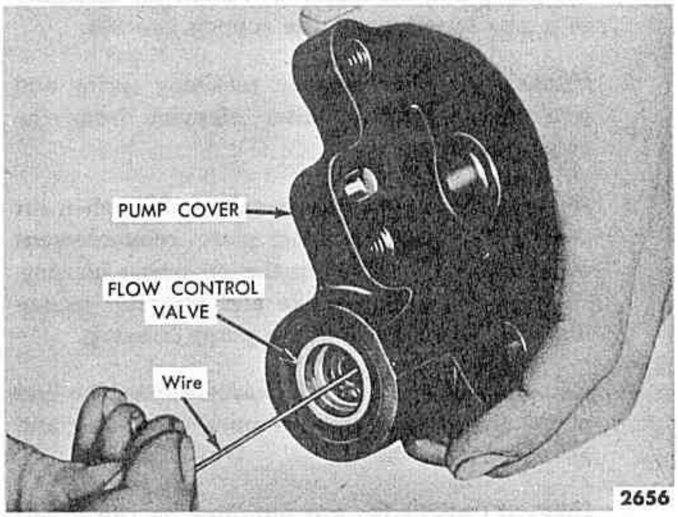

Figure 10—Pump Flow Control Valve Removal

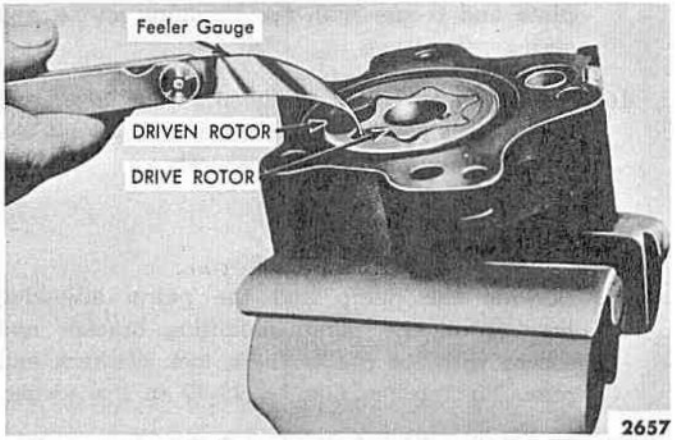

Figure 11—Checking Clearance Between Rotors

c. Check the clearance between the top of the rotors and the surface of the pump body with a feeler gauge and a straight edge as shown in Figure 12. If the clearance exceeds 0.0025 inch, replace the pump body and rotor assembly.

d. Check the clearance between the driven rotor and the insert in the pump body as shown in Figure 13. If the clearance exceeds 0.008 inch, replace the pump body and the rotor assembly. If all the clearances are within specifications, remove the rotors and bearing from the pump body.

e. Dry the pressure relief valve and the bore of the flow control valve thoroughly. Insert the relief valve in the bore, then shake the valve. If the relief valve does not move freely in the bore, remove it and check for burrs. Remove the burrs with a crocus cloth. Check the flow control valve for free movement in the bore of the pump cover. Remove burrs with a crocus cloth.

f. Check the tension of the flow control valve spring with an engine valve spring checking tool. The spring should exert a pressure of 16 pounds, plus or minus 1½ pounds, when compressed to a height of 1$^{13}/_{64}$ inches. Replace the spring if it does not meet these specifications.

g. Check the tension of the pressure relief valve spring. The spring should exert a pressure of 22 pounds, plus or minus 1 pound, when compressed to a height of 1$^{3}/_{16}$ inches. Replace the spring if it does not meet these specifications.

D. Assembly

1. Coat all parts with parts with M2C41 Hydraulic Oil, prior to assembly.

2. If the rotor shaft oil seal was removed, check the seal bleed hole for obstructions, then install a new seal as follows:

   Coat the lip of the seal with Lupriplate or equivalent. Position the seal in the bore of the pump body with the lip toward the rotors. Use a socket wrench that will bear on the outer diameter of the seal and drive it in until firmly seated.

3. Press the rotor shaft bearing onto the rotor shaft, as shown in Figure 9, until the bearing is seated against the shoulder on the shaft.

   Tap the rotor shaft and bearing assembly into the pump body until it is seated. Install the bearing retainer clip.

4. Position the pin on the shaft and install the drive rotor. Then, install the driven rotor.

5. Install a new "O" ring seal on the hose adapter fitting, then thread the fitting into the pump cover. Tighten it to 40-45 ft. lbs. torque.

6. Position a new pump cover gasket in the groove in the pump body. Install a new "O" ring seal around the flow bypass hole and retainer in the pump body.

7. Position the cover on the pump body and install lock washers and bolts in the two holes closest to the reservoir mounting pad. Tighten them to 20-25 ft. lbs. torque.

8. Install the three stud nuts that secure the pump cover to the pump body. Tighten them to 20-25 ft. lbs. torque.

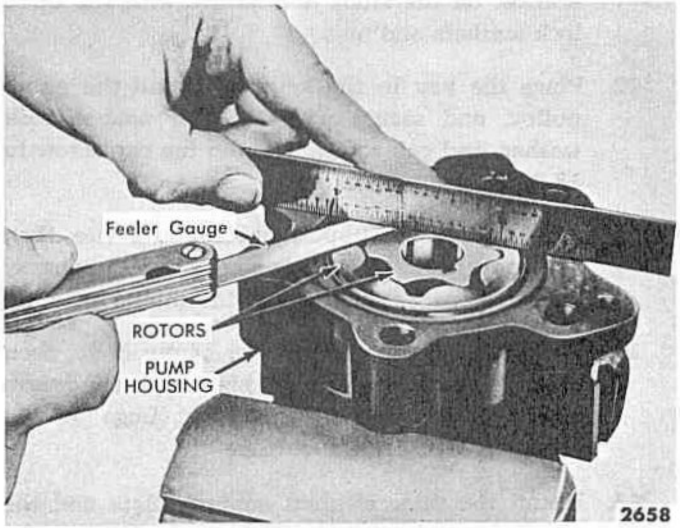

Figure 12—Checking Rotor to Pump Body Clearance

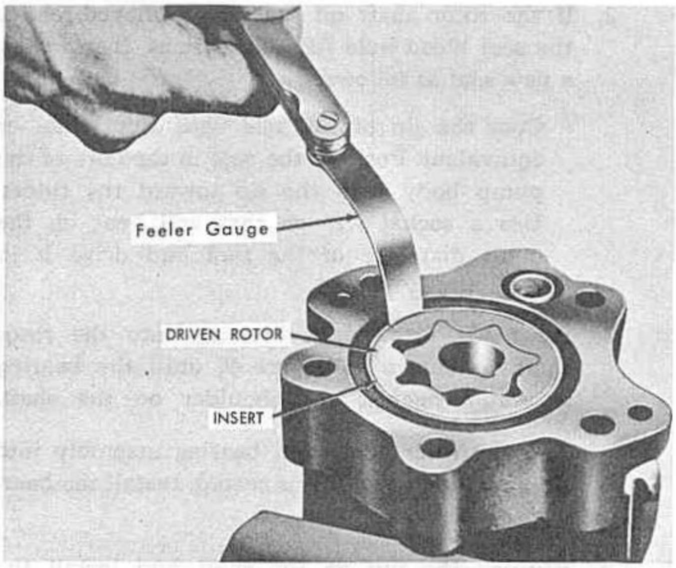

Figure 13—Checking Rotor to Insert Clearance

IMPORTANT: ***Check the rotor shaft operation to make sure it turns freely without binding. If the shaft does not turn freely, disassemble the pump to determine the cause.***

9. Insert the pressure relief valve spring and the pressure relief valve into the bore of the flow control valve and install the snap ring.

10. Insert the flow control valve into the bore of the pump cover. Be careful not to damage the valve lands or the bore of the cover. Position the orifice plate and the flow control valve spring on the valve.

11. Install the three spacers and the pump support bracket on the studs and secure with the three lock washers and nuts.

12. Place the key in the keyway, install the pump pulley, and secure with the flat washer, lock washer, and cap screw. Tighten the cap screw to 18-20 ft. lbs. torque.

13. Place the pump support bracket in a vise, then position the new gaskets on the oil reservoir mounting pad at the top of the pump body.

14. Place the oil reservoir on the pump body, then position the reinforcement plate over the pump intake port inside the reservoir. Lugs on the reinforcement plate should be up.

15. Install the filter element support plate and the reservoir retaining bolt. Tighten the bolt securely. Position the filter element on the support plate and secure with the retaining spring and spring seat.

16. Install a new gasket in the reservoir cover and position the cover on the reservoir. Install the clamp but do not tighten securely.

E. Installation

1. Position the pump and the pump adjusting bracket on the pump mounting bracket and secure with the flat washers, lock washers, and nuts. Tighten the nuts to 25-30 ft. lbs. torque.

2. Install the drive belt around the pump pulley. Raise the pump assembly to tighten the belt to obtain ¼ inch deflection at a point midway between the pulleys under 15 to 20 lbs. pressure. When the proper tension is obtained, tighten the pump bracket stud nuts to 20-30 ft. lbs. torque.

3. Attach the pump return hose to the reservoir and tighten the hose clamp.

4. Attach the pump pressure hose, Figure 1, to the pump pressure port fitting. Tighten the connection to 30-35 ft. lbs. torque.

   IMPORTANT: ***Make sure both hoses are attached to the proper pump port. If reversed, the system will not operate properly.***

5. Prior to filling the pump reservoir, and with the engine not operating, turn the tractor wheels to the left as far as possible to retract the piston in the cylinder. Remove the cover and fill the reservoir to within ⅝ inch of the top with M2C41 Hydraulic Oil. Replace the cover and bleed the system as follows:

   a. Start the tractor engine, but do not accelerate.

   b. Operate the power steering system by slowly turning the steering wheel from one extreme to the other. *Do not hold against stops.*

   c. Repeat the steering cycle until the system is free of air. Air is present when there is a turbulence or boiling action in the reservoir during the steering operation.

   d. Check the hose connections for possible oil leakage or intake of air.

   e. Turn the tractor wheels to the left and stop the engine. Refill the reservoir to within ⅝ inch of the top. Install the cover and clamp it securely.

4. STEERING GEAR

A. Removal

1. Disconnect the battery ground cable from the steering gear housing and battery bracket, Figure 14.

2. Remove the steering wheel nut and emblem and lift the steering wheel from the steering column. If necessary, use a wheel puller.

3. Remove the spring, packing, and spring seat from the top of the steering column.

4. Disconnect the throttle rod link from the bell crank and remove the two bolts which secure the throttle lever bracket to the transmission, Figure 15.

5. Remove the cotter pin, washer, spring and throttle arm from the throttle lever. Withdraw the lever from the instrument panel.

6. Remove the taillight wire and the transmission oil warning light cable from the clip on the steering gear housing.

7. Disconnect the P.T.O. handle from the hood side panel (Select-O-Speed models only).

8. Disconnect the selector assembly (Select-O-Speed models only) as follows:

   a. Loosen the nut securing the selector cable to the transmission cover.

   b. Remove the four screws attaching the selector assembly to the hood.

   c. Move the selector lever to the tenth speed position and disconnect the upper selector cable from the lower cable.

   d. Disconnect the wires to the safety switch and to the selector lamp.

9. Disconnect the Proof-Meter cable at the instrument panel.

10. Disconnect the oil pressure line at the instrument panel.

11. Remove the four screws and the four bolts and lock washers from the hood rear side panels.

12. Remove the two screws and the four bolts and lock washers from the instrument panel.

13. Remove the generator regulator from the bracket on the steering column, Figure 16.

14. Disconnect the wires from the junction block mounted on the steering column bracket. Mark the wires to insure proper installation.

15. Disconnect the temperature gauge wire from the clip on the fuel tank mounting frame.

16. Slide the instrument panel over the top of the steering column and set it on top of the hood.

17. Remove the bolt which secures the battery mounting bracket to the steering column.

18. Remove the headlight switch from the rear hood panel.

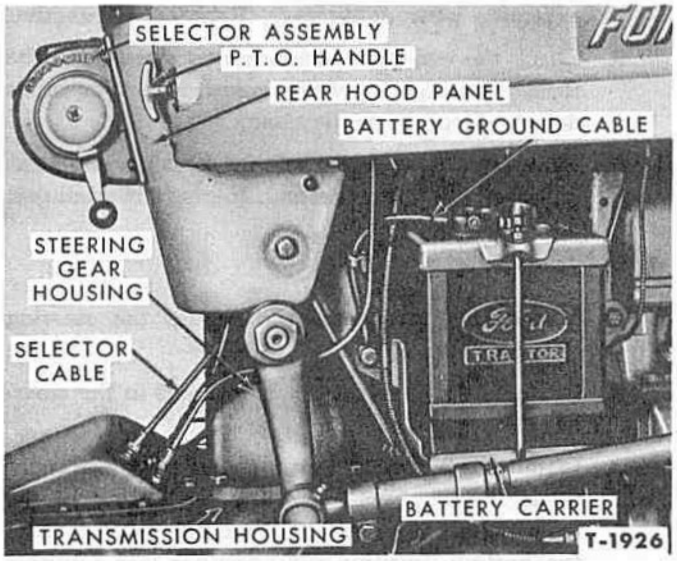

Figure 14—Steering Gear Installed

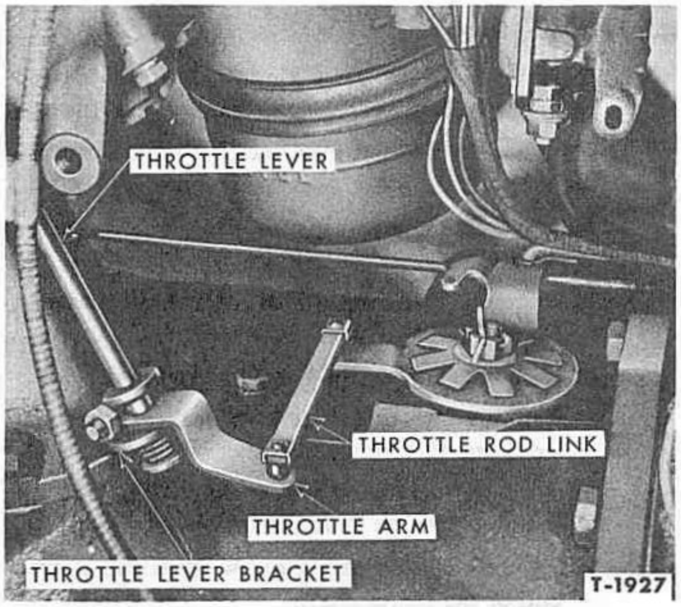

Figure 15—Throttle Linkage Installed

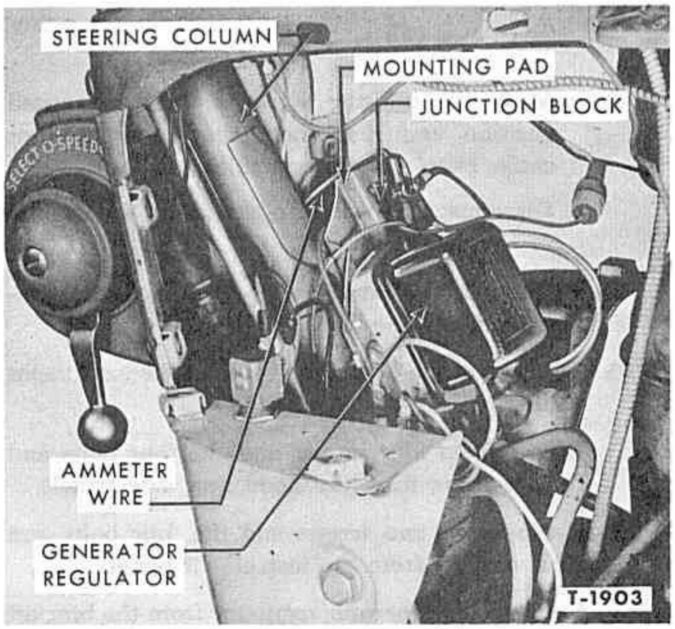

Figure 16—Steering Column with Hood Side Panel Removed

19. Remove two bolts from the rear hood panel and lift the panel off.
20. Remove the cotter pin and castellated nut which secures the drag link end to the Pitman arm and disconnect the drag link from the arm, using a puller.
21. Remove the four bolts that secure the steering gear housing, Figure 14, to the transmission case and lift the steering gear from the tractor.

B. Disassembly

1. Remove the filler plug, Figure 17, from the top of the steering gear housing and drain the oil.
2. Remove the Pitman arm and felt seals from the sector shaft. Use a puller, if necessary.
3. Remove the steering gear housing side cover as follows:
   a. Remove the three bolts and lock washers, Figure 17.
   b. Remove the stud nut and lock washer.
   c. Remove the nut, lock washers, and packing from the adjusting screw.
   d. Turn the adjusting screw clockwise until the cover is free to slide out of the housing.
   e. Remove the adjusting screw from the slotted end of the sector shaft.
4. Remove the "O" ring from the cover.
5. Remove the bushing from the cover using a suitable puller.
6. Remove the sector shaft and the thrust washer from the steering gear housing.
7. Remove the end cover and lock plate as an assembly by removing the four bolts and lock washers.
8. Disassemble the end cover by removing:
   a. Adjusting screw lock nut, Figure 23.
   b. End play adjusting screw.
   c. Adjusting lock plate bolt and washer.
   d. Backlash adjusting lock plate.
   e. Splined steering gear backlash adjuster, Figure 17.
   f. "O" ring (1955 and 1956 models only).
9. Remove the steering gear worm bearing thrust washer, Figure 17, from the bottom of the housing. Then, remove the steering shaft and worm, and the eccentric lash adjuster sleeve as an assembly.
10. Remove the eccentric sleeve and the thrust bearing from the shaft and worm assembly.
11. Remove the steering column bearing, Figure 17, from the top of the steering column.

C. Steering Gear Cleaning, Inspection, and Repair

1. Inspect the sector shaft bushings for signs of wear. If replacement is necessary, use a puller to remove them from the housing.
2. Inspect the worm and the sector gear teeth for excessive wear or damage. Replace if defective.
3. Check the eccentric lash adjuster sleeve and the thrust bearings for wear, burrs, cracks, or other defects. Replace as necessary.
4. Examine the steering column bearing for wear, distortion, or other defects. Replace if damaged.

D. Assembly

1. Install the bearing at the top of the steering column.
2. Install the two sector shaft bushings in the steering gear housing.
3. Install the eccentric lash adjuster sleeve and the thrust bearing on the worm and shaft. Then, install the entire assembly in the housing from the bottom. Position the eccentric lash adjuster sleeve so that the opening in the sleeve will

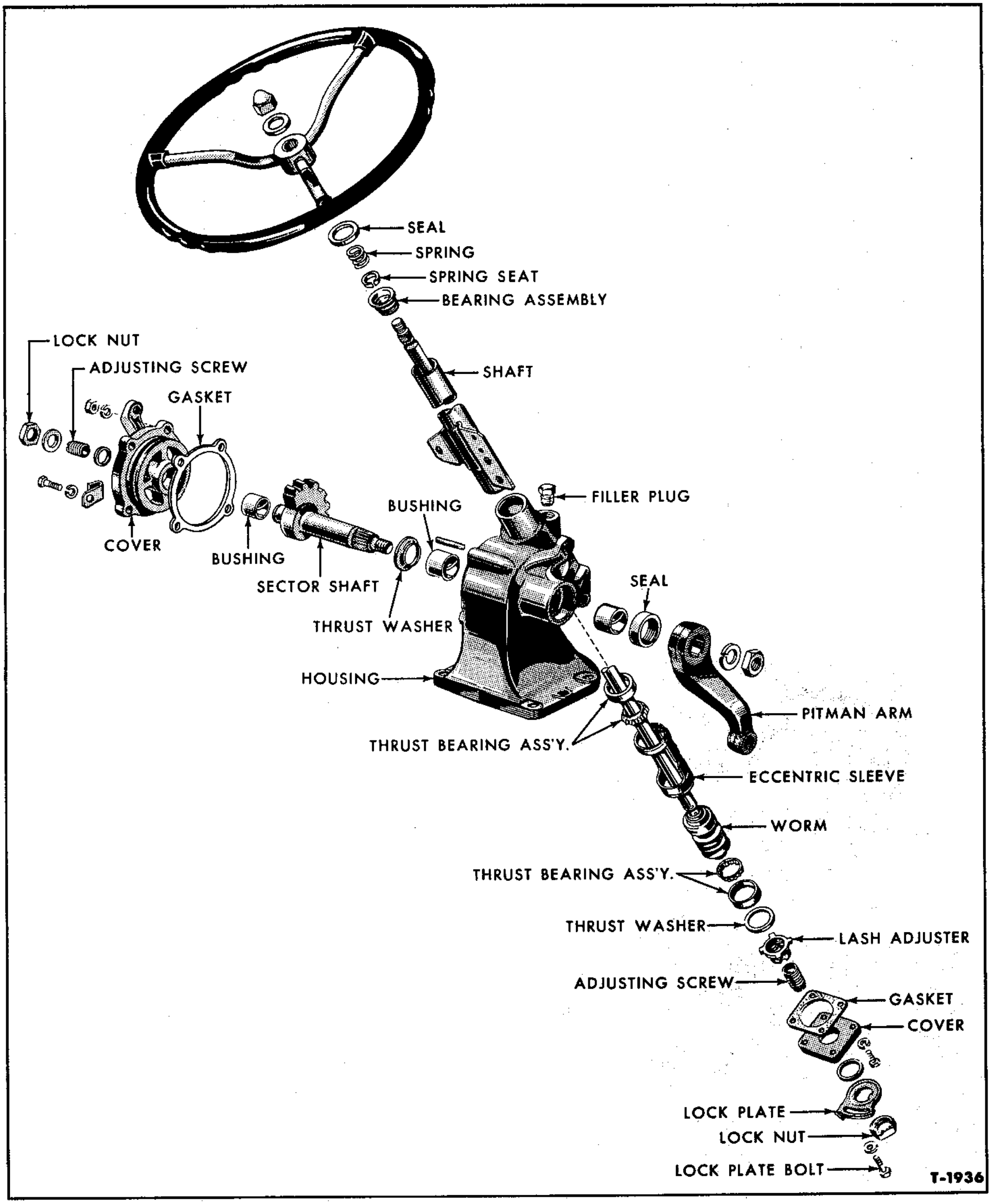

Figure 17—Steering Gear—Disassembled

allow the sector gear teeth to mesh with the worm gear. The approximate position of the sleeve is shown in Figure 18. Place the steering gear worm bearing thrust washer into the eccentric sleeve.

4. Assemble the end cover by installing the splined lash adjuster, lash adjusting lock plate and locking bolt, the adjusting screw and lock nut, and a new "O" ring (1955 and 1956 models only), Figure 17. Do not tighten the locking bolt and lock nut at this time.

5. Position the end cover on the housing so that the splines of the lash adjuster mesh with the splines of the eccentric sleeve, then secure the cover to the housing with four bolts and lock washers. Notice the position of the locking bolt in the lash adjusting lock plate slot to make sure it is approximately midway in the slot. *This is important.* After the backlash adjustment there should be approximately 3/16 inch between the bolt and the end of the slot. This provides for further adjustment to compensate for wear.

NOTE: ***Subsequent adjustments will narrow the space.***

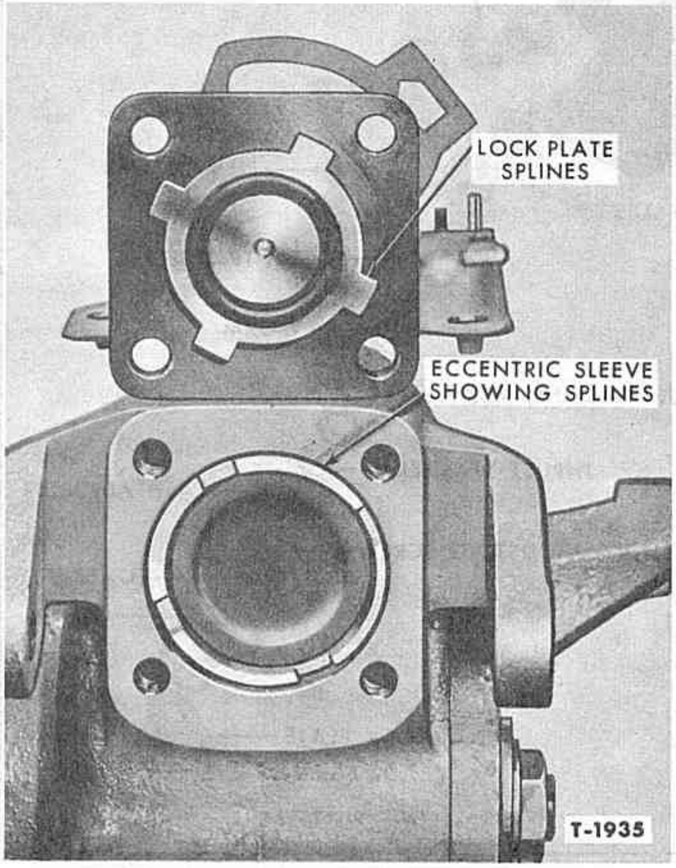

Figure 18—Eccentric Sleeve and Lock Plate Splines

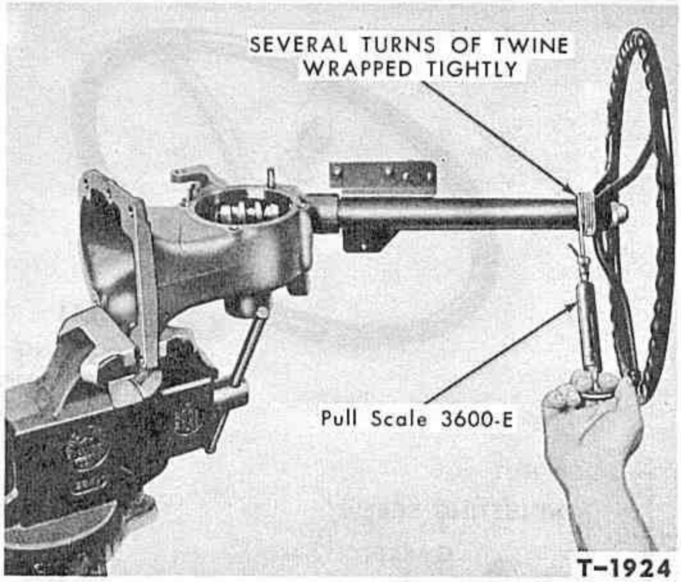

Figure 19—Checking the Worm Bearing Preload

6. Install the steering column bearing, seat, spring and felt. Position the steering wheel and emblem on the shaft and secure with the steering wheel nut. Use a piece of twine and Pull Scale 3600-E to check the preload on the worm bearings by rotating the steering wheel, as shown in Figure 19.

   Preload should be 4½ to 9 inch lbs. torque with the steering shaft positioned three turns to right or left of straight-ahead position. This is equivalent to 5 to 10 lbs. pull when checked as shown in Figure 19. Adjust the preload by turning the adjusting screw, Figure 23, in or out as necessary. Tighten the lock nut and recheck the preload to be sure it has not changed.

7. Set the steering gear shaft and worm assembly in the straight-ahead position. This can be done by observing the worm through the side cover opening and turning the steering wheel until the widths of the lands at the end of the worm are approximately the same at the casting marks as shown in Figure 20.

8. Install the thrust washer on the sector shaft, then install the sector shaft in the housing so that the middle tooth of the sector gear engages the center groove of the worm as shown in Figure 21.

9. Install a new bushing in the side cover.

10. Position a new "O" ring on the cover and attach the cover to the housing with three bolts, one nut, and four lock washers.

11. Install the packing, washer, adjusting screw, and lock nut in the side cover. Do not tighten the lock nut.

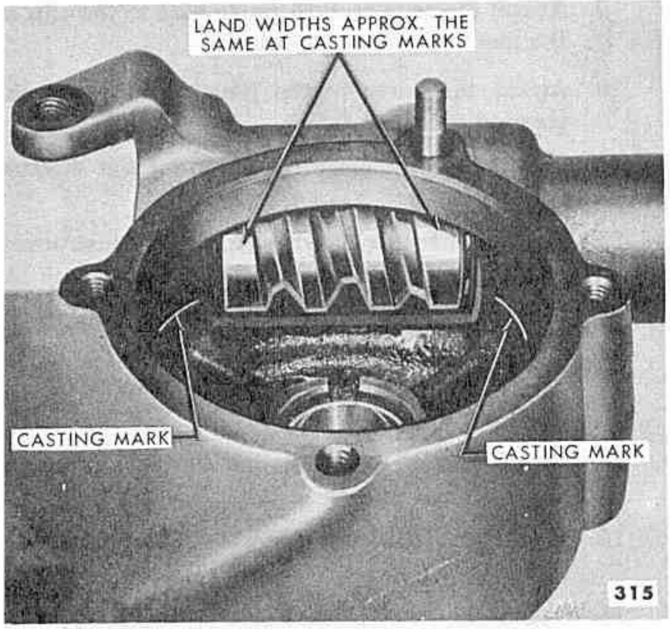

Figure 20—Positioning Worm and Shaft to the Straight-Ahead Position

12. Adjust the sector shaft end play as shown in Figure 22. Using the Pitman arm for leverage, rotate the shaft back and forth while tightening the adjusting screw. Proper adjustment exists when there is no perceptible end play and the shaft does not bind.

13. Adjust the steering gear backlash as follows:

   a. Loosen the bolt so that the lash adjusting lock plate is free to rotate, Figure 23.

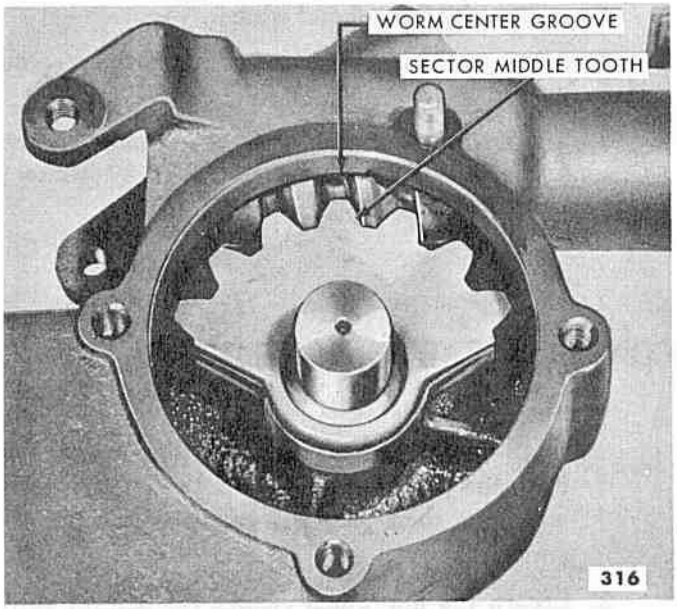

Figure 21—Sector Gear Properly Engaged with Worm

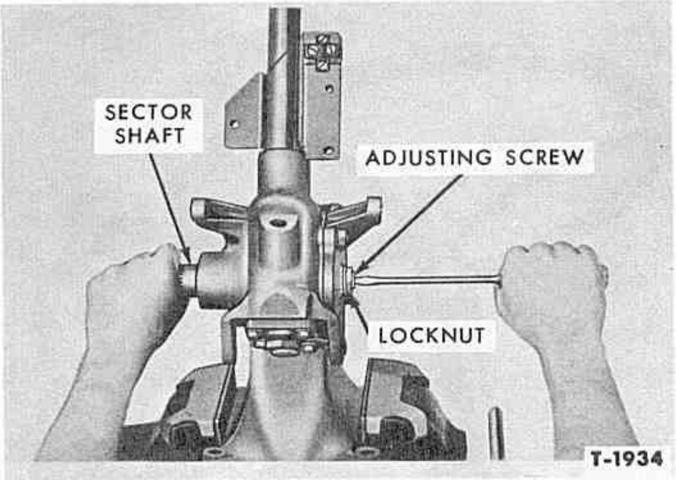

Figure 22—Adjusting Sector Shaft End Play

   b. Attach twine and Pull Scale 3600-E to the steering wheel, as shown in Figure 24.

   c. Move the lock plate, a little at a time, in a clockwise direction until a reading of 16 to 26 pounds is obtained when the steering wheel is turned through its tightest area with a pull scale. This reading is equal to 15 to 22 inch pounds which is the proper adjustment.

   d. Tighten the lock plate bolt and recheck the backlash setting.

E. Installation

1. Using a new gasket, position the steering gear housing on the transmission case and secure with four bolts and lock washers.

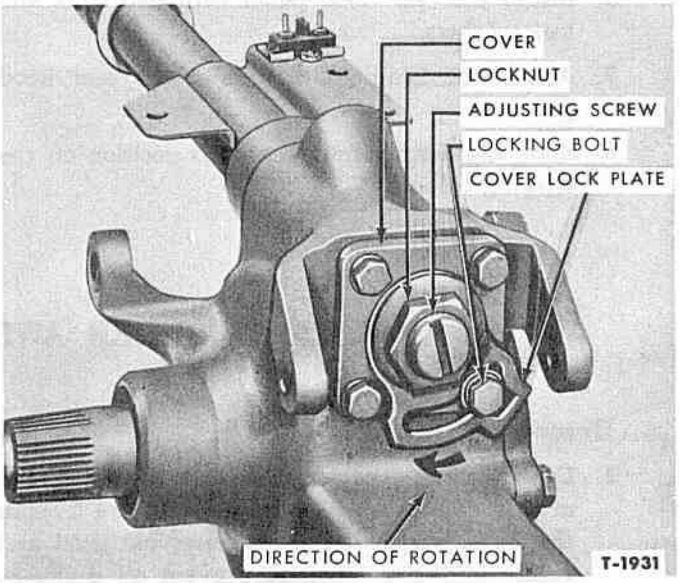

Figure 23—End Cover Lock Plate and Locking Bolt

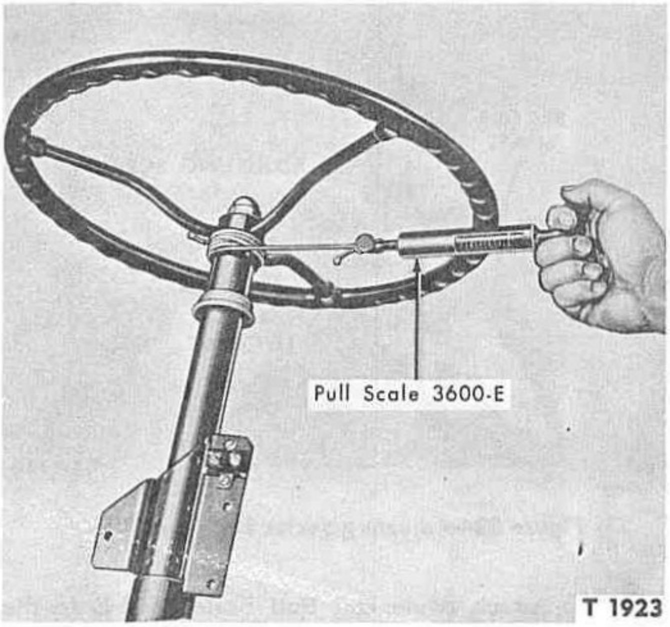

Figure 24—Pull Scale Attached to Steering Wheel Hub

2. Install the Pitman arm on the sector shaft and secure with the lock washer and nut. Tighten the nut to 140-160 ft. lbs. torque.
3. Attach the drag link end to the Pitman arm with a castellated nut and cotter pin.
4. Attach the taillight wire and the transmission oil warning light cable to the clip on the steering gear housing side cover.
5. Install the bolt attaching the battery mounting bracket to the steering column.
6. Install the rear hood panel with two bolts and lock washers.
7. Attach the headlight switch to the rear hood panel.
8. Slide the instrument panel into position on the steering column.
9. Attach the temperature gauge wire to the clip on the fuel tank mounting frame.
10. Attach the wires to the junction block on the steering column bracket.
11. Install the generator regulator on the steering column bracket.
12. Remove the steering wheel, install the instrument panel over the steering shaft and secure with the two screws, four bolts, and six lock washers.
13. Connect the P.T.O. cable conduit and attach handle to the hood side panel. (Select-O-Speed models only).
14. Attach the oil pressure line to the instrument panel.
15. Install the selector assembly (Select-O-Speed models only).
16. Attach the Proof-Meter cable to the Proof-Meter.
17. Secure the hood side panel with four screws and four cap screws and lock washers.
18. Position the throttle lever in the instrument panel and install the throttle arm, spring, washer and cotter pin.
19. Attach the throttle rod link to the throttle rod arm and to the bellcrank, and install the two bolts which secure the throttle lever bracket to the transmission.
20. Install the packing, spring seat, and spring, at the top of the steering column.
21. Position the steering wheel on the shaft and secure with the nut and washer.
22. Attach the battery ground cable to the steering gear housing.
23. Fill the steering gear with 1½ pounds of gear lubricant SAE 90 (summer) or SAE 80 (winter). Install the filler plug.

5. POWER CYLINDER AND CONTROL VALVE ASSEMBLY

A. Removal

1. Disconnect the pressure hose and the return hose at their control valve connections, Figure 1. Raise the hoses above the pump reservoir level and secure in this position to prevent oil drainage.
2. Turn the front wheels from one extreme position to the other several times to force all the oil from the power cylinder and the control valve assembly, then plug the control valve oil line ports.
3. Loosen the nut which clamps the control valve sleeve to the front end of the drag link.

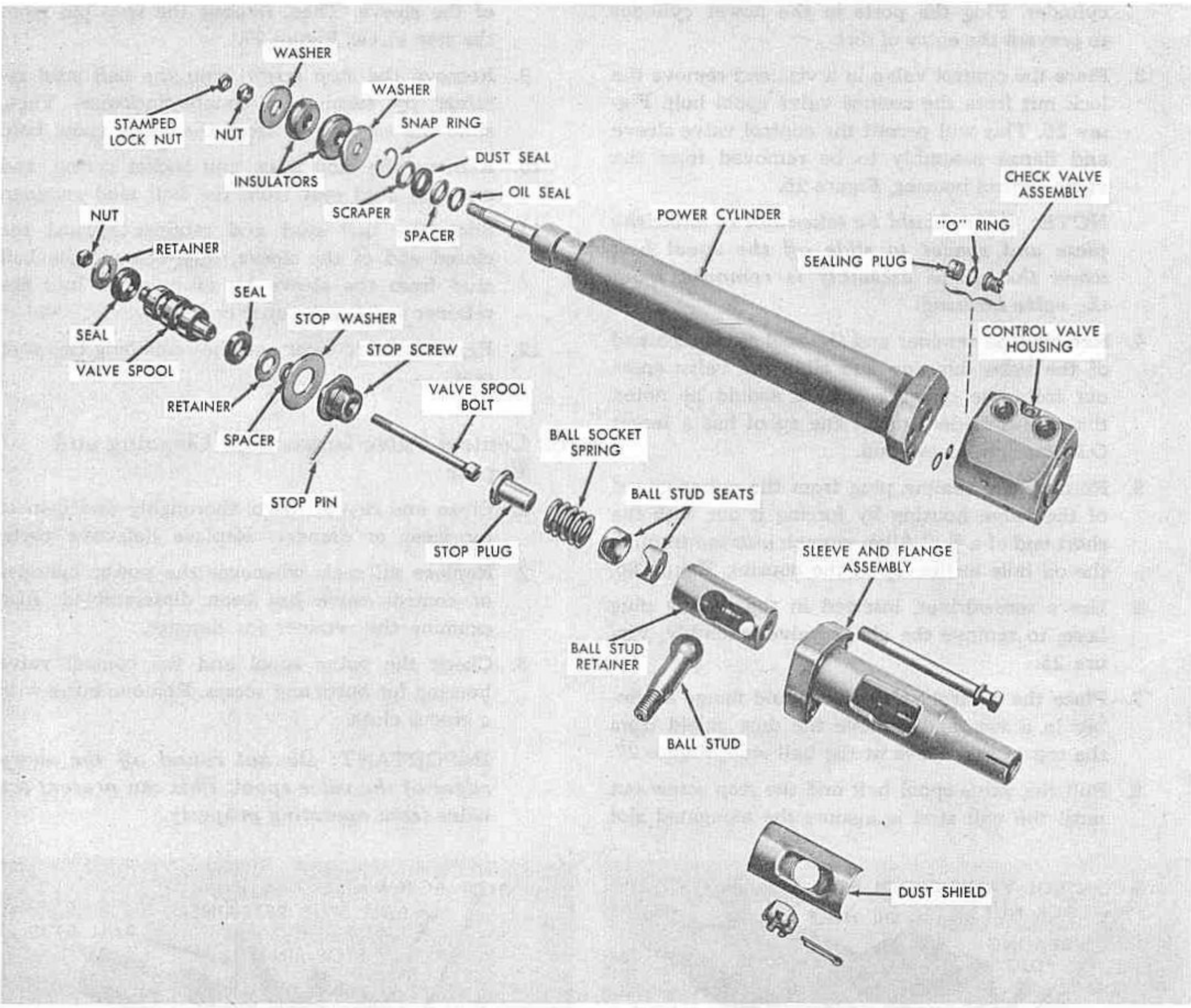

Figure 25—Control Valve and Power Cylinder—Disassembled

4. Remove the cotter pin and the castellated nut that attaches the drag link to the control valve ball stud, Figure 2. Use Gear Puller 1002, to remove the drag link from the ball stud.

   NOTE: ***Place a hex nut over the point end of the gear puller to protect the ball stud during this operation. (The ball stud is not provided with a point locating hole.) DO NOT remove the drag link from the ball stud, in any manner other than specified. The use of leverage tools applied to the sleeve assembly or to the valve housing as a fulcrum for the drag link removal can cause extensive internal damage to these assemblies.***

5. Remove the cylinder piston rod from the side rail support by removing the locking nut, jam nut, two washers, and two insulators.
6. Remove the power cylinder and control valve assembly from the front steering arm by removing the locking bolt and washer.

B. Control Valve Disassembly

1. Place the cylinder and control valve assembly in a vise, equipped with soft jaws, so that the vise grips the power cylinder just ahead of the control valve housing.
2. Loosen the three retaining bolts until the control valve assembly can be removed from the power

cylinder. Plug the ports in the power cylinder to prevent the entry of dirt.

3. Place the control valve in a vise and remove the lock nut from the control valve spool bolt, Figure 26. This will permit the control valve sleeve and flange assembly to be removed from the valve control housing, Figure 26.

   NOTE: ***Care should be taken not to allow the plate and spacer to slide off the spool bolt when the sleeve assembly is removed from the valve housing.***

4. Remove the retainer and the seal from each end of the valve housing and slide the valve spool out from the cylinder end. It should be noted that the cylinder end of the spool has a larger O.D. than the sleeve end.
5. Remove the sealing plug from the cylinder end of the valve housing by forcing it out with the short end of a 3/32" Allen wrench inserted through the oil hole in the top of the housing, Figure 26.
6. Use a screwdriver, inserted in the sealing plug bore, to remove the check valve assembly, Figure 25.
7. Place the control valve sleeve and flange assembly in a vise and remove the dust shield from the top of the sleeve at the ball stud, Figure 27.
8. Pull the valve spool bolt and the stop screw out until the ball stud is against the elongated slot of the sleeve. Then, remove the stop pin from the stop screw, Figure 27.
9. Remove the stop screw from the ball stud retainer by turning it counterclockwise. Then, slide the stop screw from the valve spool bolt.
10. Remove the stop plug, ball socket spring, and one ball stud seat from the ball stud retainer.
11. Slide the ball stud and retainer toward the closed end of the sleeve, then remove the ball stud from the sleeve by dropping it into the retainer and out the open end.
12. Remove the retainer and the remaining ball stud seat.

C. Control Valve Inspection, Cleaning and Repair

1. Clean and dry all parts thoroughly and inspect for wear or damage. Replace defective parts.
2. Replace all seals whenever the power cylinder or control valve has been disassembled. Also examine the retainer for damage.
3. Check the valve spool and the control valve housing for burrs and scores. Remove burrs with a crocus cloth.

   IMPORTANT: ***Do not round off the sharp edges of the valve spool. This can prevent the valve from operating properly.***

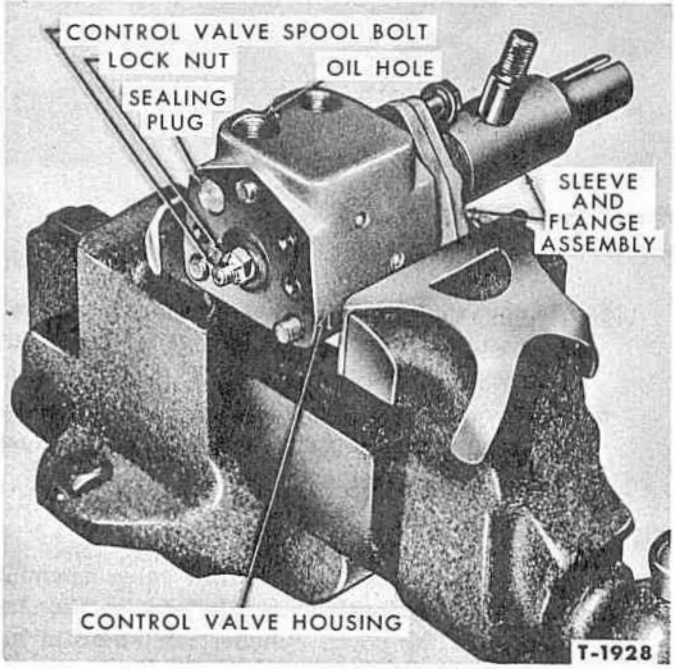

Figure 26—Control Valve with Sleeve and Flange Assembly

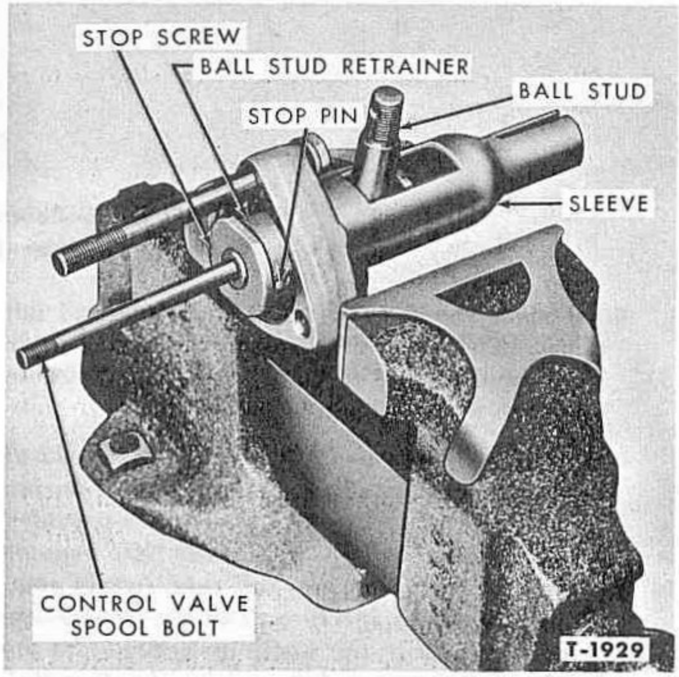

Figure 27—Sleeve and Flange Assembly with Control Valve Removed

4. Position the control valve housing with the cylinder end up, then insert the sleeve end (small O.D.) of the valve spool. The valve spool should slide into the housing freely of its own weight. The specified clearance is 0.0002 to 0.0005 inch.

5. Install the relief valve assembly in the sealing plug bore of the control valve housing, using a screwdriver.

6. Install a new "O" ring on the sealing plug and push the plug into position in its bore in the control valve housing.

7. Inspect the mating surfaces of the ball stud retainer and the sleeve for freedom from burrs, nicks, or other damage. Make sure the retainer slides freely in the sleeve.

D. Assembly of Control Valve

1. Make sure every part is clean, then lubricate with M2C41 Hydraulic Oil.

2. Position one half of the ball stud seat at the closed end of the ball stud retainer, then insert the retainer into the sleeve and flange assembly.

3. Install one of the three retaining bolts through the top of the flange on the sleeve and flange assembly.

   NOTE: ***This bolt cannot be inserted after the ball stud is installed.***

4. Insert the ball stud, threaded end first, through the open end of the ball stud retainer and lift the threaded end up through the elongated slot in the sleeve and flange assembly.

5. Position the remaining half of the ball stud seat in the retainer, followed by the spring and stop plug with head of plug toward the open end of tubes, as shown in Figure 25.

   IMPORTANT: ***Make sure that the ball stud seats are properly aligned in the retainer.***

6. Insert the valve spool bolt through the stop screw. Then, install the stop screw in the retainer. Tighten the stop screw securely, then back it off until the nearest hole in the screw is aligned with the hole in the valve spool bolt head.

7. Install the stop pin through the stop screw and the valve spool bolt.

   NOTE: ***Make sure the pin does not extend beyond the edge of the stop screw on either side.***

8. Bend the edges of the dust shield together slightly to improve the fit, then install, with short side toward the flange, over the elongated slot in the sleeve assembly.

9. Coat the valve spool with M2C41 Hydraulic Oil and insert it through the opening at the cylinder end of the control valve housing, with the smallest O.D. of the spool toward the sleeve and flange assembly.

10. Install a new seal at each end of the valve spool with the cup side in. Make sure the seal with the largest I.D. is positioned at the cylinder end of the valve housing.

    IMPORTANT: ***Be careful not to nick or scratch the seals during installation. This is important to prevent leakage during operation of the system.***

11. Install the seal retainers.

12. Check the valve spool for free movement in the housing.

13. Position the control valve stop washer around the valve spool into the counterbore in the sleeve and flange assembly.

14. Position the valve spool spacer on the valve spool bolt and against the stop screw.

15. Position the sleeve and flange assembly on the valve housing by inserting the valve spool bolt completely through the bore of the assembled control valve spool. Make certain that the counterbore in the flange locates on the pilot in the valve housing. Since the top retaining bolt has already been installed through the top of the flange, it will have to be positioned simultaneously through the top bolt hole in the control valve housing. When thus positioned, the retaining bolt should be aligned with the pressure and return ports in the valve housing and with the ball stud in the sleeve and flange assembly.

16. Install the retaining lock nut on the cylinder end of the valve spool bolt. Tighten the nut to seat the parts solidly, then back it off approximately one-half turn to allow the valve spool to rotate freely with a minimum amount of end play.

17. Install the two remaining retaining bolts through the sleeve and flange assembly and through the control valve housing.

E. Power Cylinder Disassembly, Inspection and Repair

The design of the power cylinder does not provide for repair of the piston or the piston rod. If internal failure occurs, the complete unit must be replaced. However, seals and other external parts can be replaced if worn or damaged.

1. Clean dirt from the cylinder assembly and clamp the assembly in a vise.

2. Remove the snap ring, Figure 25, from the rod end of the cylinder.

3. Pull the piston rod outward to remove the scraper and the dust seal, Figure 25.

4. Apply compressed air to one of the two ports in the end of the cylinder to blow the spacer and oil seal from the rod end of the cylinder. If this is not successful, use a pointed instrument to pry out the spacer and oil seal.

5. Examine the dust seal and oil seal for wear or damage. Replace if defective.

6. Lubricate the new oil seal, then install the seal (cup toward piston), spacer, dust seal, and scraper in the rod end of the power cylinder using a $\frac{11}{16}$ inch deep wall socket.

7. Install the snap ring.

F. Assembly and Installation of Power Cylinder

1. Use new "O" rings at the two oil transfer ports in the control valve housing.

2. Clamp the power cylinder in a vise. Position the control valve on the end of the cylinder, lining up the transfer ports, and secure with the three retaining bolts. Tighten them to 35-50 ft. lbs. torque.

3. Install the power cylinder and the control valve assembly as follows:

   a. Raise the tractor front end to free the wheels, then align the front steering arm vertically as shown in Figure 28.

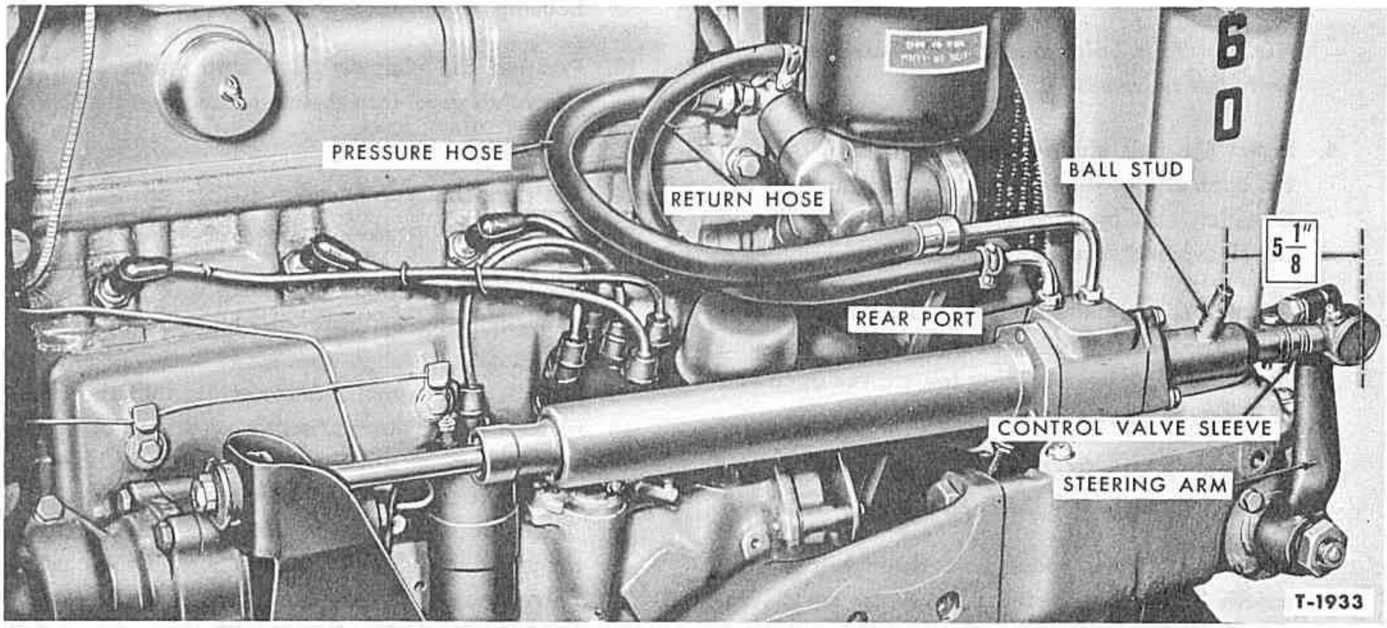

Figure 28—Adjustment of Power Cylinder and Control Valve to Steering Arm

b. Insert the power cylinder front stud into the front steering arm and secure with the lock washer and bolt. Torque to 40-50 ft. lbs.

c. Install the inner insulator washer and the insulator on the cylinder piston rod so that the washer bears against the rod shoulder.

NOTE: ***The inner insulator washer has an I.D. of 0.515 to 0.525 inch. The outer washer has an I.D. of 0.464 to 0.474 inch.***

d. Position the cylinder piston rod through the hole in the side rail rod support and install the insulator and the outer insulator washer.

e. Secure the rod to the support with a nut tightened to 20-25 ft. lbs. torque. Lock the nut in position with the hex stamped nut. Torque to 12-16 ft. lbs.

5. Adjust the distance from the center of the ball stud in the sleeve and flange assembly, to the center of the ball stud in the steering arm by rotating the cylinder and control valve assembly. The distance between these centers should be 5⅛" as shown in Figure 28.

NOTE: ***The face of the control valve housing containing the oil ports must be at the top and on a horizontal plane when this adjustment is completed.***

6. After proper adjustment is obtained, tighten the nut which secures the control valve sleeve to the drag link front end.

7. Install the pressure hose and the return hose to the ports at the top of the control valve. The return hose (attached to reservoir) should be attached to the rear port.

8. Turn the tractor steering wheel to align the hole at the front end of the drag link with the control valve ball stud in the sleeve and flange assembly. Attach the drag link to the ball stud with a castellated nut and cotter pin. Tighten the nut to 75-90 ft. lbs. torque.

NOTE: ***Make sure that the ball stud is kept in a vertical position when connecting it to the drag link.***

9. The length of the assembled drag link should be 44⅝ inches from the ball stud to ball stud as shown in Figure 29. Adjustment is made by loosening the sleeve clamp nuts and turning the screw-type sleeve to lengthen or shorten the drag link as required. Tighten the clamp nuts after adjustment has been made.

10. Replenish the system with hydraulic fluid as described on page 310.

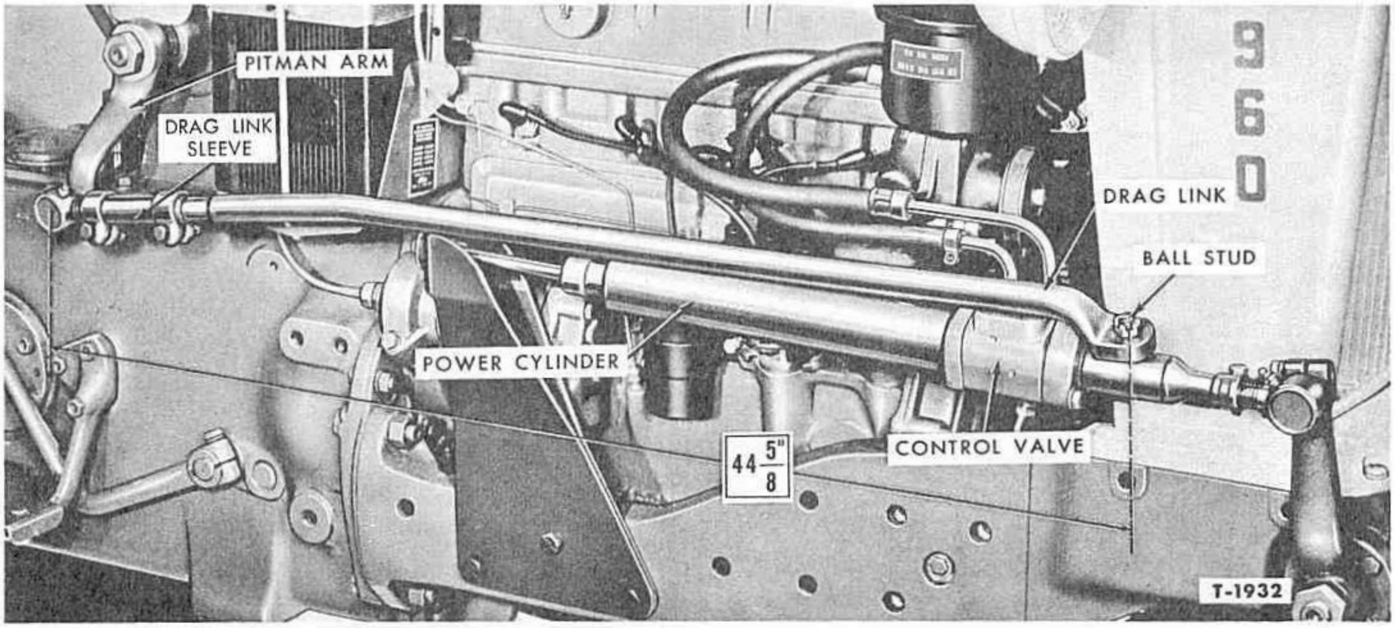

Figure 29—Drag Link Adjustment

6. TROUBLE SHOOTING

See Chapter 1-C Page 338.

7. SPECIFICATIONS

Pump

Capacity	1.5 gpm @ 900 rpm and 600 psi
Type	Rotor
Drive	Belt
Maximum Operating Pressure	1100 psi

Cylinder

Type	Double Acting

Torque Limits	**Ft. Lbs.**
Pump Flow Control Valve Fitting	40-45
Pump Cover to Pump Body Bolts	20-30
Belt Adjusting Bracket to Pump Body Stud Nuts	25-30
Pump Pulley Retainer Bolt	18-20
Belt Adjusting Bracket to Pump Support Bolts	25-30
Hose to Pump Pressure Fitting Valve Assembly to Power Cylinder Retaining Bolts	35-50
Cylinder Rod Retainer Nut	20-25
Cylinder Rod Support Bracket to Side Rail Bolts (3)	135-150

8. SPECIAL TOOLS

Removal and disassembly of the power steering components on "Row Crop" tractors can be accomplished without the use of special tools. However, it will be helpful to use Puller 1002 from the FT-48 Kit to disengage the power cylinder stud from the front steering arm.

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS, AND TIRES

Chapter

1-C

Power Steering—Industrial Tractors

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1. CONSTRUCTION AND OPERATION

The power steering information given in this chapter applies only to "Industrial" tractors. For information on other models, refer to pages 282 to 300 ("General Purpose" tractors), or pages 301 to 322 ("Row Crop" tractors).

Power steering components of the "Industrial" tractor consist of four assemblies: Pump and Reservoir Assembly, Cylinder and Valve End Assembly, Actuator Housing, and Control Cable and Conduit Assembly, Figure 1.

The entire steering system is actuated hydraulically. There is no mechanical operating linkage between the steering wheel and the front wheels.

A description of the design and function of each assembly plus complete overhaul instructions is given in the various sections of this chapter as outlined above.

A. Power Steering Pump

All "Industrial" tractors are equipped with a roller vane type pump located at the front right side of the engine. The pump is belt driven from the engine crankshaft. A turnbuckle attached between the pump support bracket and the fuel tank bracket adjusts belt tension.

The pump consists chiefly of a six-lobed carrier, Figure 5, which is keyed to the pump drive shaft and which rotates within a cam ring installed in the cast iron pump body. Six hollow rollers are located between the lobes of the carrier and act as vanes within the cam ring as they are driven by the carrier. The drive shaft is supported at each end by bronze bushings pressed into the pump body and into the pump cover. A lip-type, spring-loaded oil seal is installed between the bushing and the pulley at the outer end of the shaft.

As the pump shaft and carrier rotate, the clearance volume of pockets formed between the carrier lobes and cam ring increase in size, then decrease in size to propel oil from the suction (intake) side to the pressure side of the pump. Minimum output of the pump (at engine idle speed) provides sufficient hydraulic power to turn the front wheels.

The oil reservoir is attached to the top of the pump by an open center stud, Figure 5, which threads into the pump body. This stud is used also to attach, inside the reservoir, the support bracket for a replaceable filter element. A spring-loaded hook, installed through the center of the element and the stud, holds the element in place on the support. Should the filter become clogged, the spring seat acts as a relief valve, allowing oil to bypass the filter. During operation, oil flows from the return line through the filter element to the reservoir. Oil enters the pump through an opening at the bottom of the reservoir. To keep the

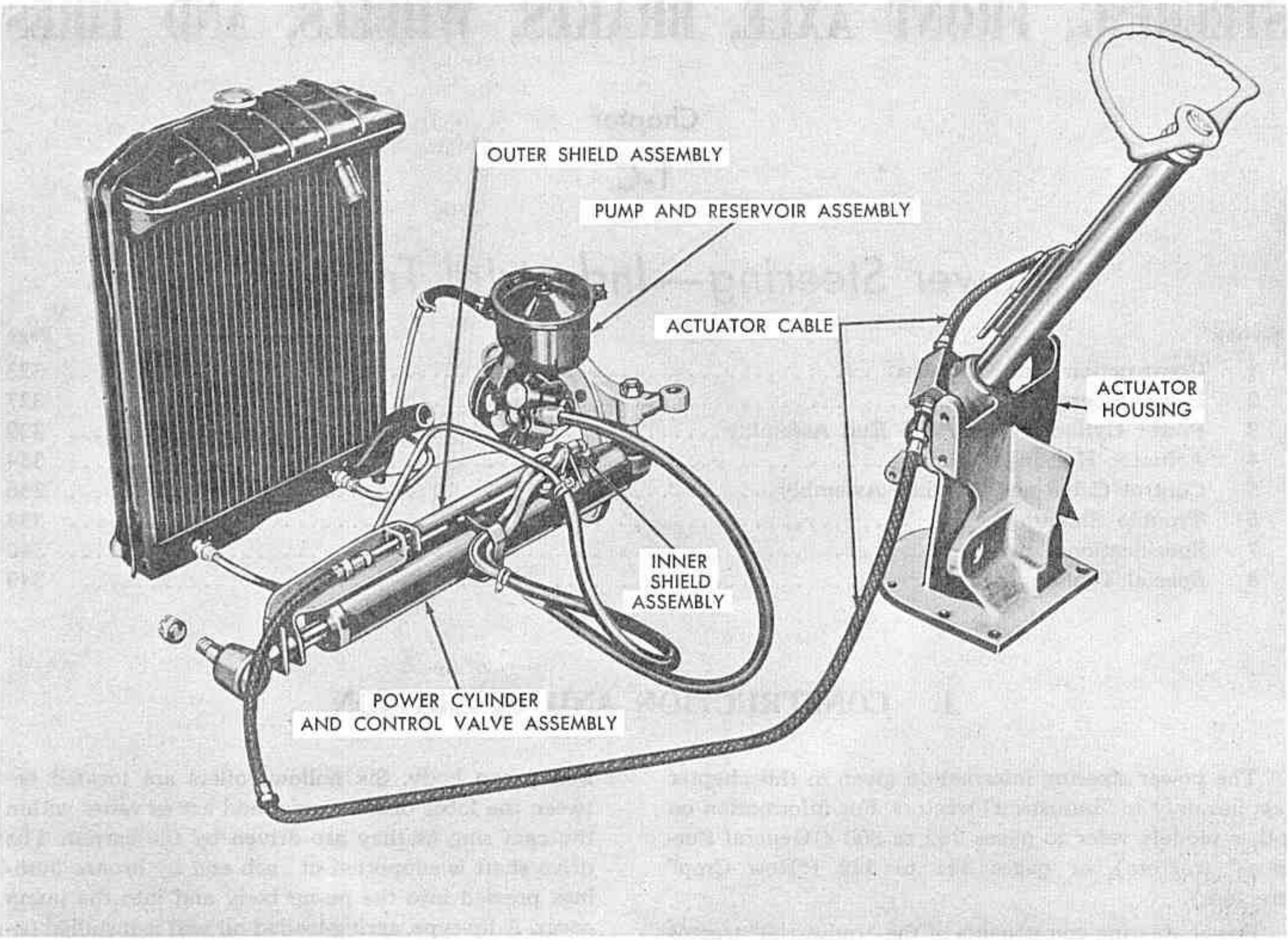

Figure 1—Power Steering System Components

system oil temperature down, the oil is circulated through a tank in the base of the tractor radiator. The oil level should be maintained to within ⅝ inch of the top of the reservoir.

A spool-type, spring-loaded flow control valve, Figure 8, mounted in the bore of the pump cover, is designed to limit oil flow to a maximum of 9.5 gallons per minute. The control valve, which is hollow and closed at one end, has metered holes located in the valve grooves. Whenever pump volume is greater than is permitted by the metered holes, a pressure is built up at the back of the valve. This forces the valve toward the pump intake port and relieves the excess volume.

A spring-loaded, pressure relief valve, with a calibrated orifice at its head, is mounted inside the flow control valve. It functions to limit the pump pressure to a maximum of 1550 psi. When pump pressure reaches 1300 psi, a ball in the relief valve is unseated and the pressure is relieved through the calibrated orifice. When the pressure is relieved, the control valve will move toward its spring and oil will return to the intake side of the pump in the same manner as when the flow control valve is operating to limit flow only.

B. Cylinder and Valve End Assembly

The cylinder and valve end assembly is mounted directly behind the front axle, Figure 10. The rod end of the cylinder is attached to the axle and the opposite end is attached to the right steering arm.

The control valve is located between the operating stud and the inner tube assembly. The rod end of the assembly is a double walled tube containing a piston and a rod. Two oil passages interconnect the inner tube of the cylinder with the control valve. These passages serve as either pressure lines or return lines in directing oil to or from either end of the cylinder, depending on the turn being made.

The control valve assembly consists of the valve housing, valve spool, spool guide, spacer tube, and operating stud, Figure 13.

In operation, oil is directed from the pump to the control valve through the connecting hose and tubing. When the steering wheel is turned, the actuator cable moves the operating stud to which it is attached. The stud, in turn, moves the control valve spool which directs oil, under pressure, to one side of the piston or the other, depending on the turn being made. Oil from the opposite side of the piston is forced out and back to the pump reservoir via the oil cooling segment of the tractor radiator.

When the turning action of the steering wheel is stopped, the cylinder travels about 0.008 inch further and comes to rest at the neutral position with respect to the valve.

C. Actuator, Cable, and Steering Assembly

The steering efforts of the operator are transmitted to the control valve through the mechanical control linkage of the steering wheel, steering shaft, actuator assembly, actuator cable assembly, and reduction housing on late model tractors.

The actuator assembly is mounted in the location usually occupied by the conventional steering gear. The actuator housing contains the steering shaft operated by the steering wheel. The actuator wheel, which is mounted on the lower end of the shaft, Figure 19, is splined to two actuator wheel bushings. The wheel bushings are driven by frictional washers which are held in contact with the wheel bushings by a compression spring. The compression of the spring is adjusted by a self-locking nut threaded to the bottom of the shaft. The steering shaft is held in a centered position in the actuator housing by a spacer pressed into the base of the housing.

The actuator cable is threaded into the actuator housing and engages the actuator wheel. Movement of the cable is limited by a cable stop, housed in the tube at the valve end of the cable. When the cable reaches the end of its travel, the friction washers slip on the actuator wheel bushings. Thus, any further turning of the steering wheel and shaft in the same direction will not transmit movement to the cable.

D. Straight-Ahead Driving

When the tractor front wheels are positioned straight ahead, the control valve spool will be in its center or neutral position, Figure 2. In this position, oil from the pump flows past the valve spool lands and is returned to the reservoir. Thus, the oil will simply be recirculated without doing any work.

E. Left Turning

Turning the steering wheel to the left causes the actuator and cable assembly to move the control valve operating stud to the right. This moves the valve spool toward the right end of the cylinder and permits oil, under pressure, to be directed to the right side of the piston, Figure 3. Since the piston rod on the left side of the piston is attached in a stationary position to the axle, the cylinder, attached to the right steering arm, is moved to the right, causing the tractor to turn left.

When the wheels are fully turned, a stop on the actuator cable engages a stop in the slider tube assembly. This engagement causes the friction washers on the steering shaft to override the actuator wheel bushings, preventing further thrust from the steering

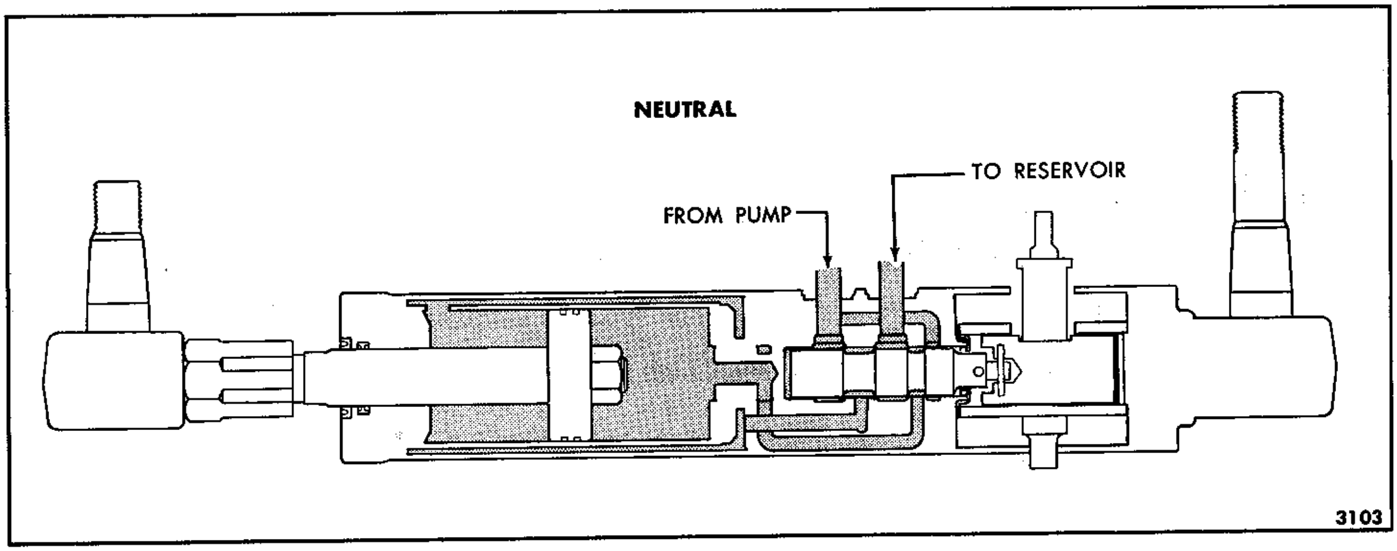

Figure 2—Flow Diagram—Oil Flow with Control Valve in Straight-Ahead Driving Position

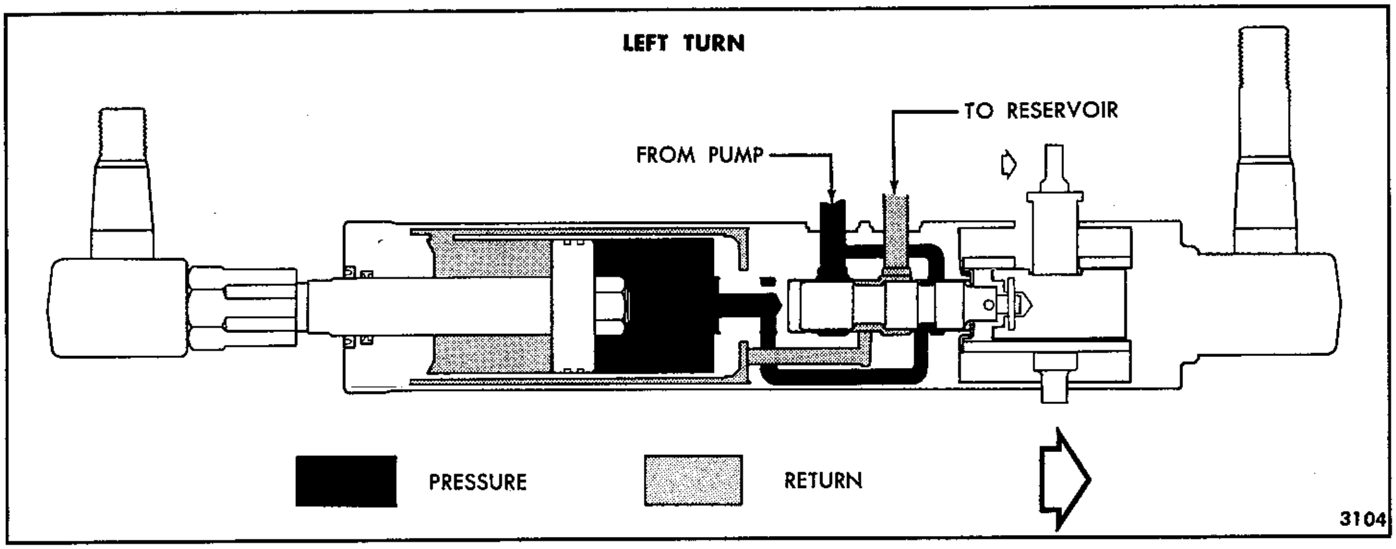

Figure 3—Flow Diagram—Oil Flow with Control Valve in Left Turn Position

wheel to be transmitted to the actuator cable and thus to the control valve and power cylinder assembly.

When the turning movement of the steering wheel is stopped, or when the actuator cable has reached the limit of its travel, the power cylinder continues its travel about 0.008 inch before it comes to rest at a neutral position with respect to the control valve spool. In this position, the hydraulic force applied to the steering linkage is removed.

F. Right Turning

When the steering wheel is turned to the right, the actuator wheel causes the cable to move the valve spool to the left or toward the rod end of the cylinder, Figure 4. In this position, the spool directs oil, under pressure, to the rod end of the cylinder. This forces the cylinder to move to the left on the piston rod and pulls the right steering arm so that the tractor front wheels turn to the right.

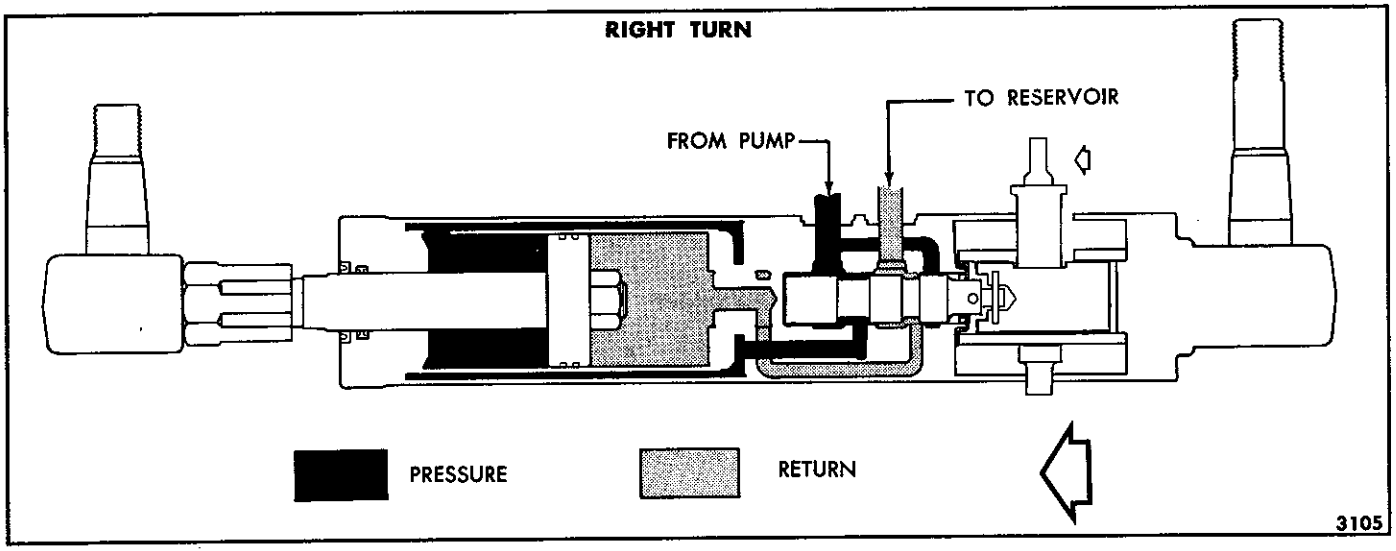

Figure 4—Flow Diagram—Oil Flow with Control Valve in Right Turn Position

2. POWER STEERING PUMP

A. Removal

1. Remove the cover from the reservoir, Figure 5, and withdraw as much oil as possible, using a suction gun.
2. Loosen the turnbuckle to relieve the belt tension, then remove the drive belt.
3. Disconnect the turnbuckle from the pump by removing the cotter pin and the clevis pin.
4. Disconnect the pressure and return lines from the pump assembly.
5. Remove the bolt which secures the pump support to the water outlet connection and remove the pump and the support.

B. Disassembly

1. Drain the remaining oil from the pump. Clean the outside of the pump and the reservoir. Seal the pressure and return ports to prevent dirt from entering.

NOTE: ***Before disassembly, make sure the bench and the surrounding area are clean.***

2. Mount the pump support in a vise with the pump in a vertical position. Disconnect the filter retainer and remove the retainer, spring, spring seat, and filter element from the reservoir, Figure 5.
3. Remove the reservoir retaining stud, lift out the filter element support and the reinforcement plate. Remove the reservoir and the gaskets from the top of the pump.
4. Remove the pulley retaining bolt, lock washer, and flat washer as an assembly, then slide the pulley and the key from the pump shaft.

IMPORTANT: ***Do not hammer. Use a puller if necessary.***

5. Loosen the three bolts securing the pump cover to the pump body. Separate the support from the pump by removing the two bolts.

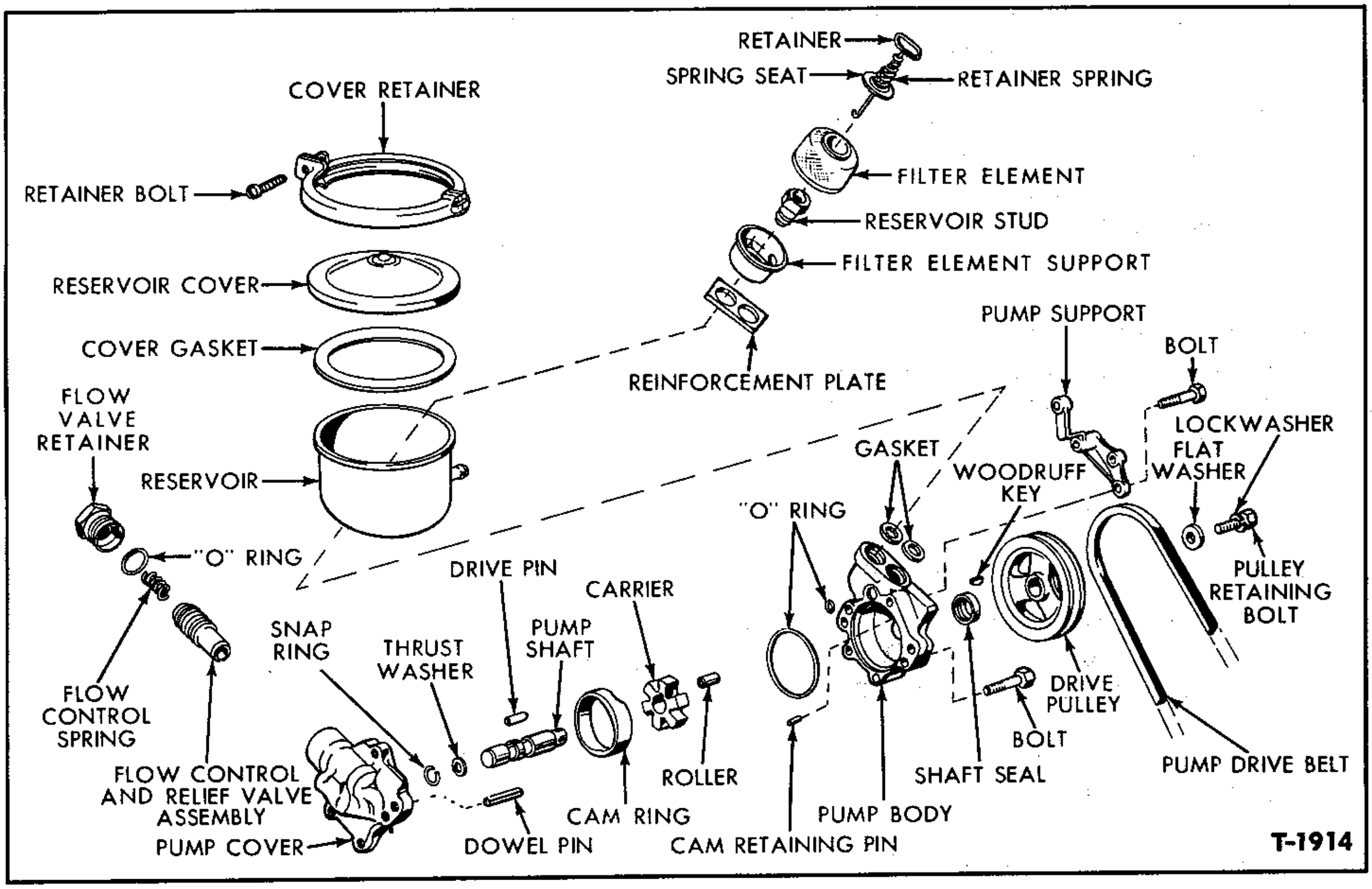

Figure 5—Roller Vane Type Oil Pump—Disassembled

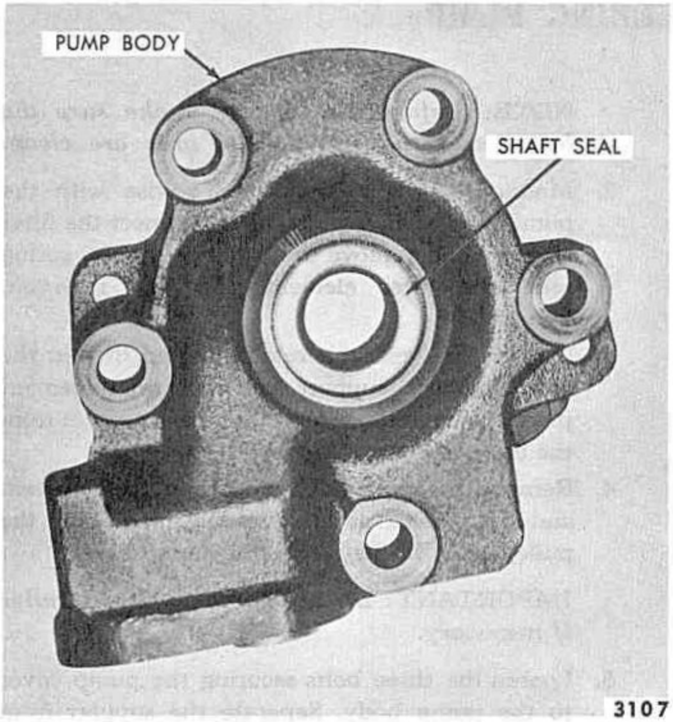

Figure 6—Shaft Seal Installed in Pump Body

6. Remove the three bolts from the pump cover and lift the cover vertically from the pump to prevent the internal parts from falling out.
7. Remove the two "O" rings from the pump body.
8. Remove the pump shaft from the cover end of the pump body and remove the thrust washer and the snap ring.
9. Remove the carrier and the six rollers from the pump body.
10. Remove the cam ring and retaining pin.
11. Remove the shaft seal from the pump body. Be careful not to damage the shaft bushing.
12. Disconnect the hex head flow valve fitting and remove the spring and the relief valve assembly from the pump cover.

C. Cleaning, Inspection, and Repair

1. Wash all the parts in a solvent and air dry.
2. Check the pump body and the cover for damage and the shaft bushings for wear. Replace them if necessary.
3. Install a new shaft seal (metal side out) in the pump body, Figure 6. Coat the seal lip with M-1C31 grease.
4. Inspect the cam ring for wear. Replace it if it is worn or damaged. Insert the retaining pin in the hole in the pump body. Position the cam ring over the retaining pin and push the cam ring in to seat it firmly.
5. Lubricate the shaft and the shaft seal with Lubriplate or an equivalent, then carefully install the shaft from the cover end of the pump body. Insert the Woodruff key and install the pulley and screw assembly temporarily to prevent the shaft from falling out.
6. Place the carrier drive pin in its groove on the shaft and install the carrier so that with the pulley end of the shaft down, the carrier lobes will be angled in a clockwise direction. Install the snap ring to retain the carrier on the shaft.
7. Inspect the rollers, paying particular attention to the finish on the ends and outside. Replace them if scored, damaged, or out-of-round.
8. Check the end clearance of the carriers and the rollers, Use a straight edge and a feeler gauge as shown in Figure 7. If the end clearance exceeds 0.0015 inch, replace the carrier and/or rollers.
9. Inspect the valve assembly and the valve bore for burrs, cracks, or other defects. Use a crocus cloth to remove the burrs.

D. Assembly

1. Position the shaft thrust washer in the cover with the concave side toward the shaft end.
2. Position the pump body and the cover together using new "O" rings. Secure them loosely with the three short bolts, then remove the pulley.
3. Position the pump support to the pump and secure them with the two long bolts.
4. Tighten all five bolts evenly to 20-25 ft. lbs. torque. After tightening the bolts, rotate the shaft to make sure it does not bind.

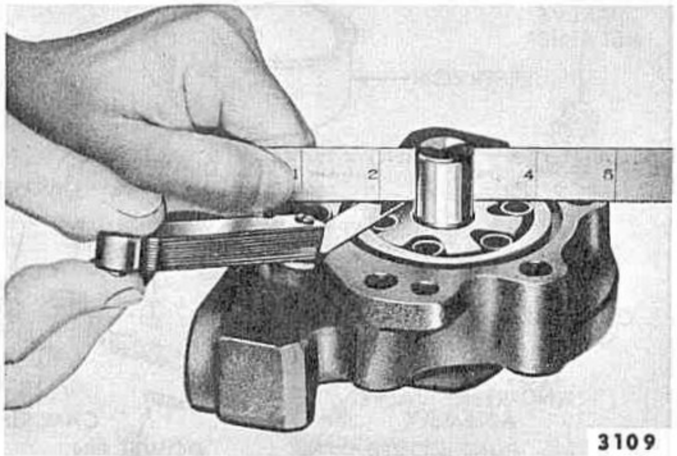

Figure 7—Checking Clearance of Carrier and Rollers in Pump Body

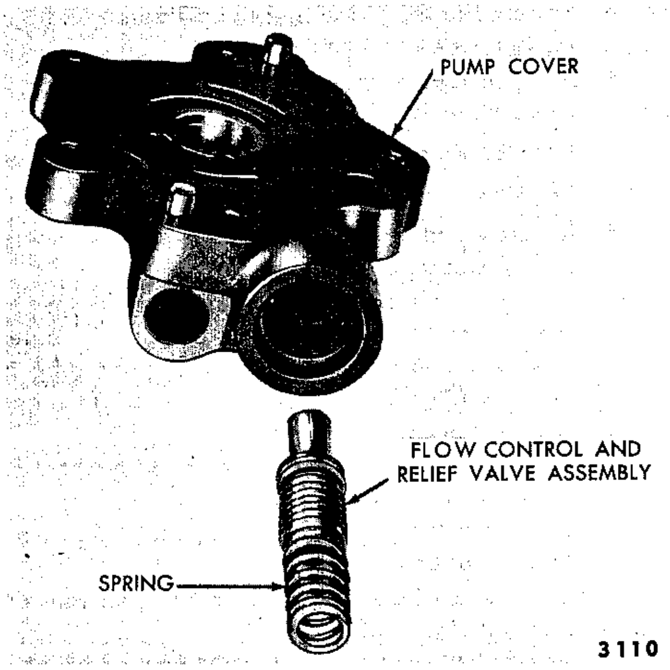

Figure 8—Installing Pump Flow Control Valve

5. Assemble the spring to the flow control valve and insert the valve in its bore so that the valve extension enters first, Figure 8. Make sure the valve does not stick. Using a new "O" ring, install the valve retainer and tighten it to 30-35 ft. lbs. torque.
6. Install new "O" rings in the grooves at the top of the pump body.
7. Position the reservoir, reinforcement plate, and filter element support to the pump body. Secure with the reservoir stud tightened to 30-35 ft. lbs. torque.
8. Install the filter element and secure with the reservoir retainer, spring, and spring seat. Depress the retainer and hook it to the bottom of the bore.
9. Insert the key and install the pulley with the flat side toward the pump body. Install the flat washer, lock washer, and pulley retaining bolt. Tighten the bolt to 15-20 ft. lbs. torque.

E. Installation

1. Mount the pump support to the water outlet connection and secure with the bolt.
2. Install new "O" rings on the pressure fitting and connect the pressure and return lines to the pump.
3. Place the drive belt around the pump pulley.
4. Attach the turnbuckle to the pump support with the clevis pin and cotter pin.
5. Adjust the turnbuckle to obtain ¼" belt deflection midway between the pulleys under 15-20 lbs. pressure.
6. Fill the reservoir to within ⅝ inch of the top with M2C41 hydraulic oil and install the cover.
7. Operate the engine at idle speed while turning the tractor wheels through their complete range several times. Then, stop the engine and add fluid to within ⅝" of the reservoir level.
8. Check the belt tension for proper deflection. Because proper belt tension is very important, it should be rechecked after 30 minutes operation.

3. POWER CYLINDER AND VALVE END ASSEMBLY

A. Removal

1. Remove the boot from the operating stud and remove the large cylinder shield, if tractor is so equipped.
2. Set a drain pan under the power cylinder and disconnect the pressure hose and the return hose at the cylinder and remove the clamp, Figure 9.
3. Remove nut (C), Figure 10, from the cable end and disconnect the tube bracket from the cylinder at (B), by removing the two bolts and washers.
4. Disconnect the piston rod end, Figure 11, from the axle by removing the cotter pin and the castellated nut from the rod end. Then, pull the rod end out of the axle bore from the rear. Remove the flat washer from the rod end.
5. Disconnect the cylinder end of the power cylinder from the right steering arm by removing the cotter pin and castellated nut (D), Figure 10, to free the assembly as shown in Figure 11.

   NOTE: *The right front wheel has been removed in Figure 10 for purposes of illustration only.*
6. Unscrew the rod end assembly, Figure 9, from the piston rod using two wrenches. One wrench should engage the flats on the piston rod.

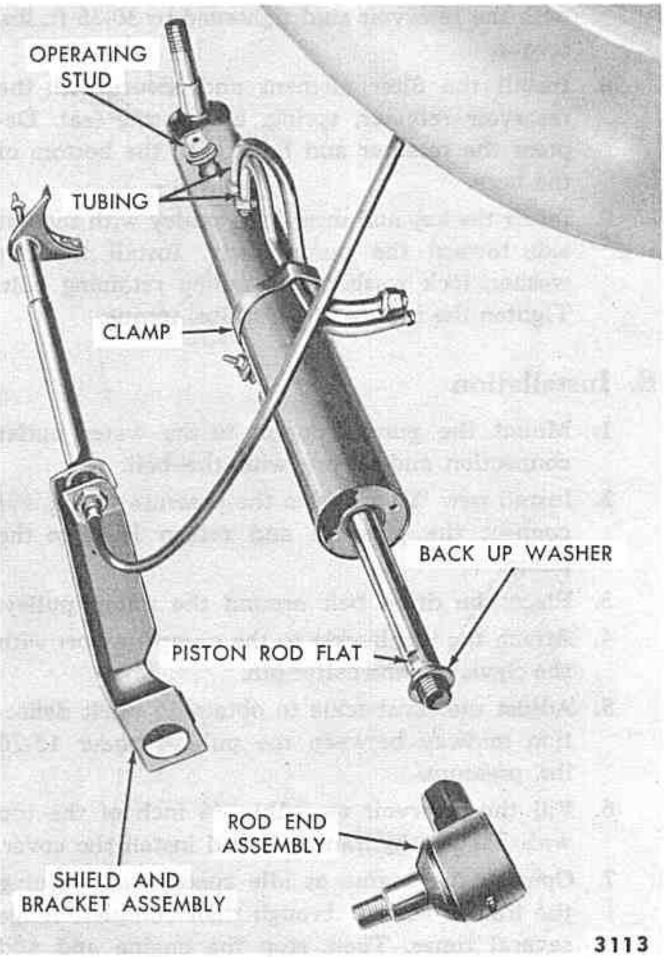

Figure 9—Cable and Shield Assembly Removed from Cylinder

IMPORTANT: ***Do not use a pipe wrench on the cylinder rod for removing the rod end assembly.***

7. Slide the shield bracket and back-up washer from the cylinder piston rod and pull the cable end out of the operating stud at the opposite end of the cylinder, Figure 9.

B. Disassembly

1. Clamp the assembly horizontally in a vise, gripping it somewhere near the center. To avoid distorting the outer tube, do not tighten the vise excessively.
2. Loosen the rod guide and seal assembly, Figure 18, with a pin-type spanner wrench. Unscrew the guide and seal from the outer tube and remove the guide, inner tube, piston and rod, Figure12.
3. Remove any paint, dirt, or burrs, from the end of the rod and carefully slide the guide and seal assembly from the rod.
4. Pry out the wiper seal and the "T" ring seal from the bore of the rod guide.
5. Remove the valve end operating stud and dust cap, Figure 13.

   NOTE: ***Turn the stud 90° to clear the guide opening.***
6. Unscrew and remove the cylinder end assembly from the outer tube, Figure 12.
7. Remove the valve end assembly from the piston rod end of the outer tube by tapping the outer tube on a bench (note that the outer tube is flared at the rod end to facilitate removal of the control valve).
8. Remove the guide from the valve spool support, Figure 13.
9. Drive out the roll pin securing the valve spool support to the valve spool.
10. Remove the inner plug, Figure 12, from the "O" ring end of the valve housing.

    NOTE: ***The plug which is held in the valve body by two "O" rings, may be removed with the fingers or pliers.***
11. Remove the valve spool from the inner plug end of the valve.
12. Remove the retainer and "O" ring from the opposite end of the valve body.

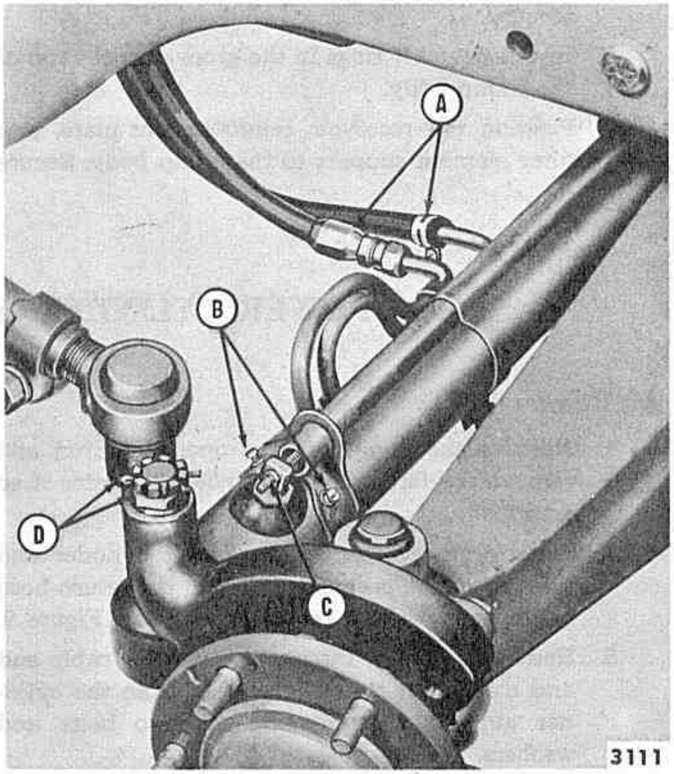

Figure 10—Power Cylinder Assembly with Boot and Shields Removed

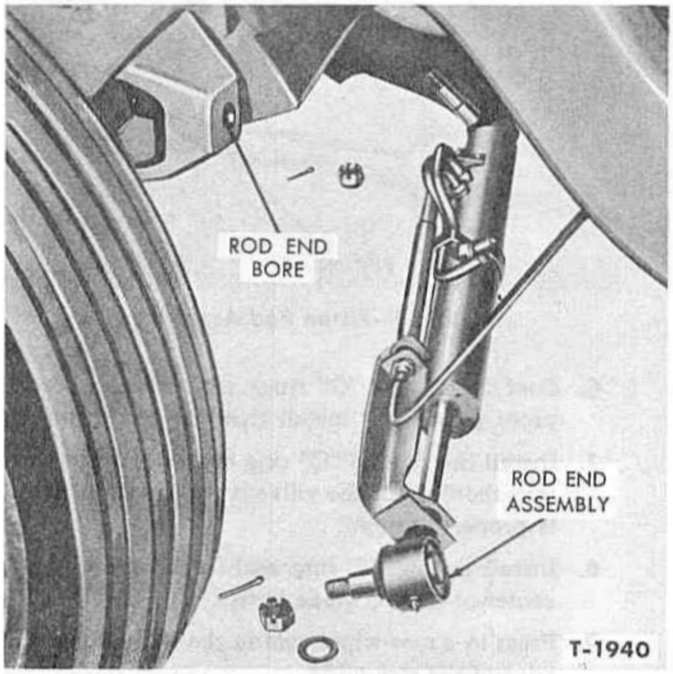

Figure 11—Power Steering Cylinder Assembly Removed

13. Drive out the roll pin which secures the brass connecting pin to the valve spool.
14. Remove the valve spool plug from the valve spool.

C. Inspection

1. Remove all "O" rings and seals and discard them. Then, clean all parts in a suitable solvent.
2. Inspect the valve body and the spool carefully for scoring or damage. Coat the spool with a film of light oil and check its fit in the valve body. The spool should slip through the body freely of its own weight.

   NOTE: ***The valve spool and valve body are select fits and are serviced only as an assembly.***

3. Inspect the inner tube, piston, piston ring, and piston rod for wear or scoring. Replace parts as necessary.
4. Examine the operating stud bushing and the end assemblies for wear or damaged threads. Replace defective parts.
5. Install new "O" rings and seals.

D. Assembly

Lubricate all parts with Lubriplate or equivalent, before assembling.

1. Install the valve spool plug in the valve spool. (Location is unimportant since the plug will seek its own position during operation of the system.)

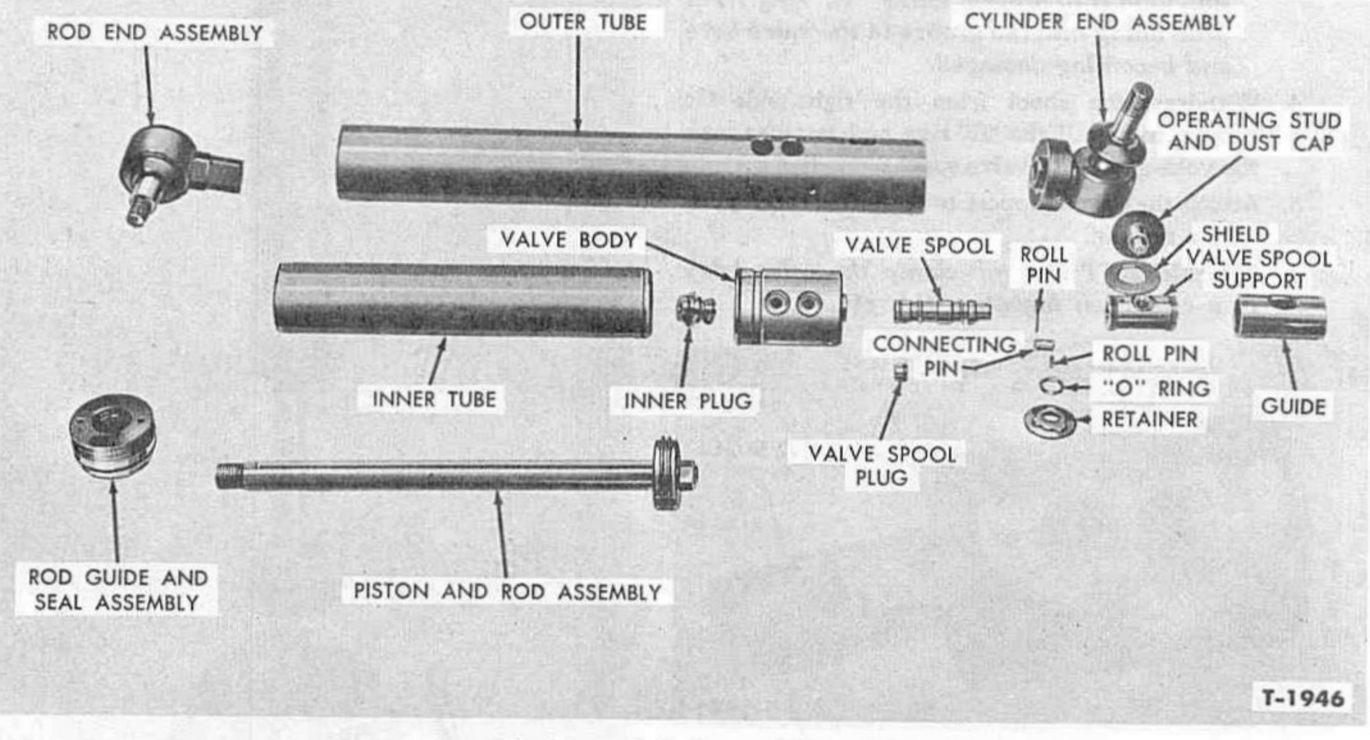

Figure 12—Power Cylinder and Valve End—Disassembled

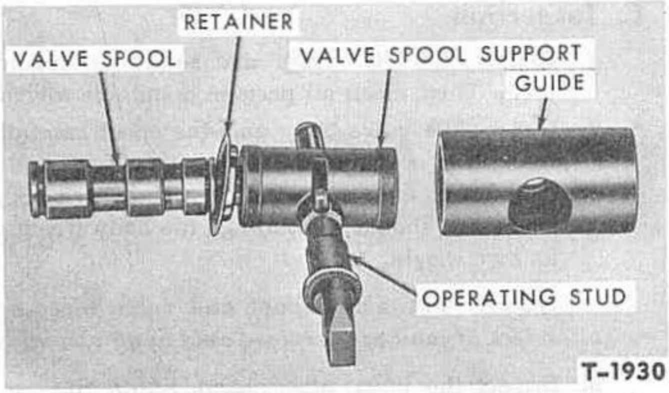

Figure 13—Control Valve Guide and Operating Stud

2. Use a roll pin to attach the brass connecting pin to the valve spool.
3. Install the valve spool in the valve body.
   a. Position the valve body so that the inner plug end ("O" ring groove on the outside) is on your left.
   b. Position the valve spool so that the yoke end is on your right and the spool is at the left side of the valve body, Figure 14.
   c. Insert the spool into the valve body so that the left end of the spool extends far enough to clear the "O" ring groove. Then, install the "O" ring.

   NOTE: *The reason for this method of installation is to prevent either "O" ring from protruding into the groove in the valve bore and becoming damaged.*
4. Withdraw the spool from the right side far enough to install the "O" ring and retainer over the yoke end of the valve spool.
5. Attach the valve support to the valve spool yoke with a roll pin.

   IMPORTANT: *Do not clamp the valve body in a vise when installing this pin.*

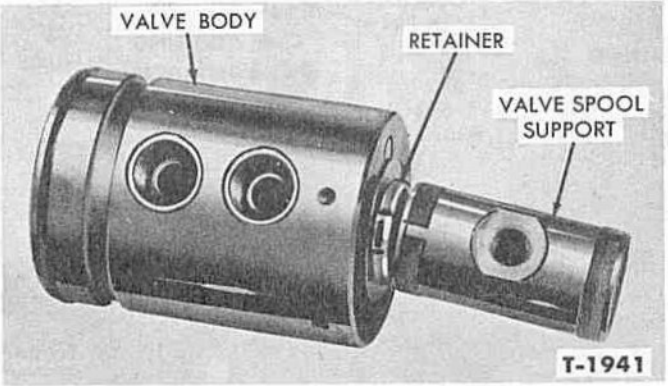

Figure 14—Valve End Body, Spool, and Guide Assembly

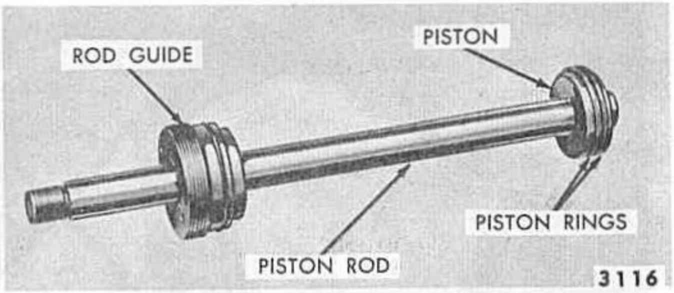

Figure 15—Piston Rod Assembly

6. Coat three new "O" rings with white or waterproof grease and install them on the inner plug.
7. Install the double "O" ring end of the inner plug into the bore of the valve body. Be sure the plug is properly seated.
8. Install a new "T" ring seal in the groove at the center of the rod guide bore.
9. Press in a new wiper seal in the bore at the outer edge of the rod guide.
10. If required, install new rings on the piston.
11. Make sure the rod surface is smooth, then slide the rod guide onto the rod, Figure 15.

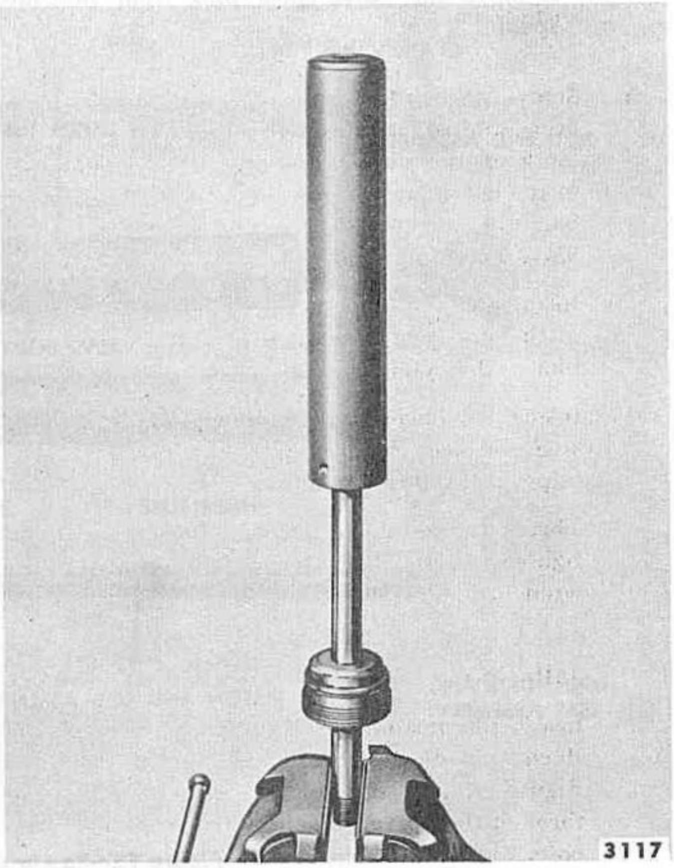

Figure 16—Assembling Inner Tube to Piston and Rod

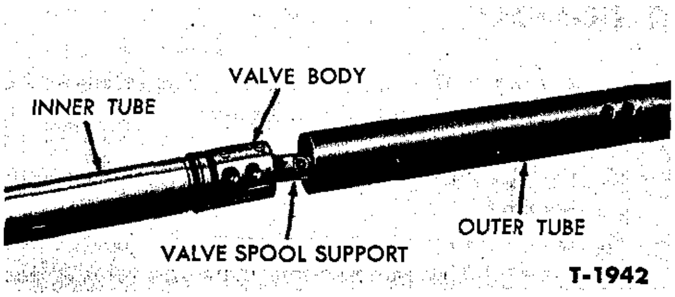

Figure 17—Installing Inner Tube Into Outer Tube

12. Clamp the flats at the threaded end of the rod in a vise, Figure 16. Make sure the vise does not grip the threads.
13. Install the inner tube on the piston and rod assembly.
14. Connect the valve body assembly to the inner tube assembly by inserting the inner plug end into the hole in the inner tube.
15. Install the valve body with the inner tube and the piston and rod assembly into the outer tube. Make sure the ports in the valve body are aligned with the holes in the outer tube, Figure 17.
16. Install the guide over the valve support at the right side of the valve body.
17. Screw the cylinder end assembly into the operating stud end of the outer tube until the peening mark on the threads line up with the ⅛″ hole in the outer tube. This is necessary to align the ball stud in the end assembly with the control valve operating stud.
18. Install the valve operating stud. The flat surface of the stud, when installed, should be perpendicular to the cylinder.
19. Install the lower stud retaining ring around the stud and over the grommet, then install the stud upper seal and retaining ring.
20. Thread the rod guide into the outer cylinder and tighten to 200-230 ft. lbs. Use a pin-type spanner wrench, Figure 18.

E. Installation

1. Insert the piston rod through the hole at the shield end of the shield and bracket assembly, Figure 9, and position the control cable end through the operating stud. Then, install the two bolts and lock washers that attach the bracket to the cylinder.

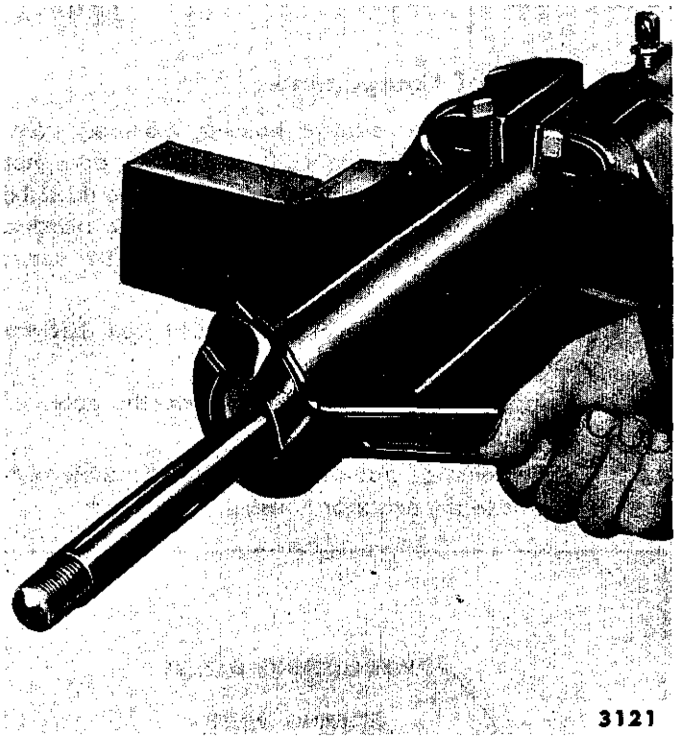

Figure 18—Installing Piston Rod Guide Assembly

2. Install lock nut (C), Figure 10, on the end of the control cable.

   NOTE: ***Control cable adjustment should not be necessary providing that the cable and conduit assembly slider tube has not been disturbed during cylinder removal. If adjustment is required, refer to Section 5, CONTROL CABLE AND CONDUIT ASSEMBLY—INSTALLATION, step 3 and step 8.***

3. Slide the back-up washer, Figure 9, on the piston rod and install the rod and assembly. Torque the nut to 135-140 ft. lbs.

   NOTE: ***Use wrenches to engage the flats on the piston rod and on the rod end assembly. DO NOT USE A PIPE WRENCH.***

4. Position the cylinder end of the power cylinder to the right steering arm and secure with the castellated nut and the cotter pin (D), Figure 10.
5. Position the piston rod end assembly to the bore in the front axle, Figure 11, and secure with the castellated nut and the cotter pin.
6. Attach the pressure and the return hoses to the cylinder and install the clamp.
7. Install the cylinder shields on tractors so equipped.

4. ACTUATOR HOUSING

A. Removal of Components

Removal of the actuator housing assembly components and the steering shaft and wheel does not require removal of the actuator housing. Should it be necessary to remove this housing for other reasons, follow the procedure described on page 292 under Steering Gear Removal.

1. Remove the battery and loosen the battery carrier.
2. Remove the actuator cable from the actuator housing as follows:
   a. Remove the nut which attaches the cable conduit to the actuator housing.
   b. Rotate the steering wheel counterclockwise until the actuator cable comes completely out of the housing.

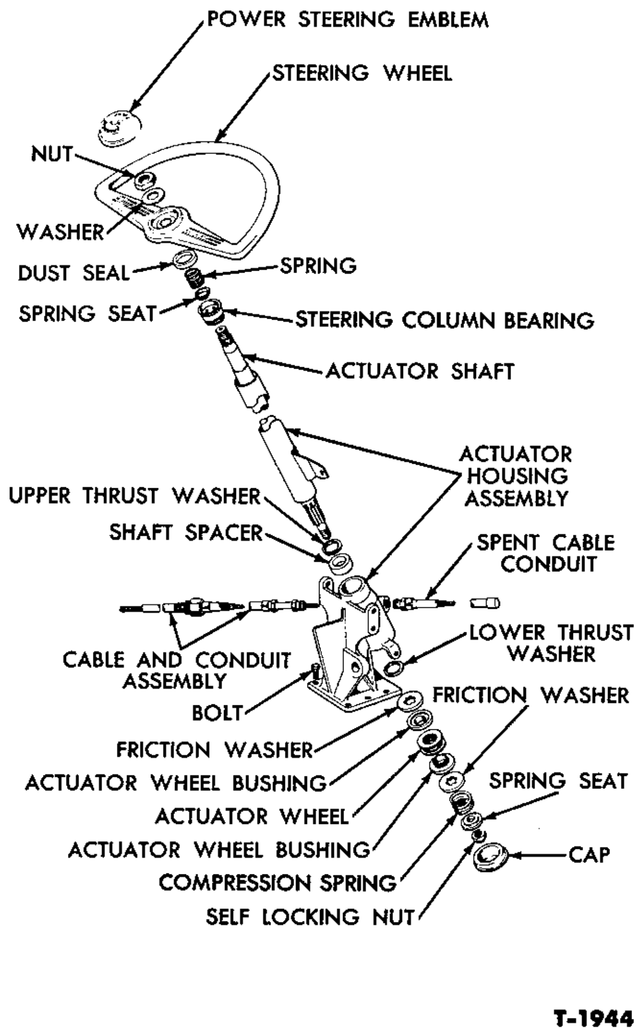

Figure 19—Actuator Assembly—Disassembled

3. Pry the dust cap from the bottom of the actuator housing.
4. Hold a wrench on the self-locking nut at the lower end of the steering shaft and remove the nut by turning the steering wheel counterclockwise.
5. Remove the following components, Figure 19, from the lower end of the steering shaft:
   a. Spring Seat
   b. Compression Spring
   c. Friction Washer
   d. Actuator Wheel Bushing
   e. Actuator Wheel
   f. Actuator Wheel Bushing
   g. Friction Washer
   h. Lower Thrust Washer
6. Pry the steering hub cover from the steering wheel and remove the steering wheel nut, emblem, and steering wheel. If a puller is necessary, use the type shown in Figure 20, to prevent distortion of the steering wheel spokes (Puller 1002, Gear Puller 951).
7. Remove the spring, felt packing, and spring seat from the top of the steering column.
8. Lift the steering shaft from the actuator housing. If necessary, tap the bottom of the shaft gently with a soft-faced hammer. The steering column bearing will be removed from the top of the column when the shaft is withdrawn.
9. Drive the steering shaft spacer out of the bottom of the actuator housing. Remove the spacer and the upper thrust washer.

B. Inspection

1. Clean all parts thoroughly in a suitable solvent.
2. Inspect the steering shaft for damage to the splines or to the threads.
3. Check the friction surfaces of the friction washers, actuator wheel bushings and actuator wheel for damage. Replace if necessary.
4. Examine the splines on the friction washers, actuator wheel bushings, and actuator wheel. Replace defective parts.
5. Check the spring, spring seat, and bearing to make sure they are in good condition.
6. Inspect the bearing surface of the shaft spacer and the thrust bearing for scoring, nicks, or burrs. Replace damaged parts.

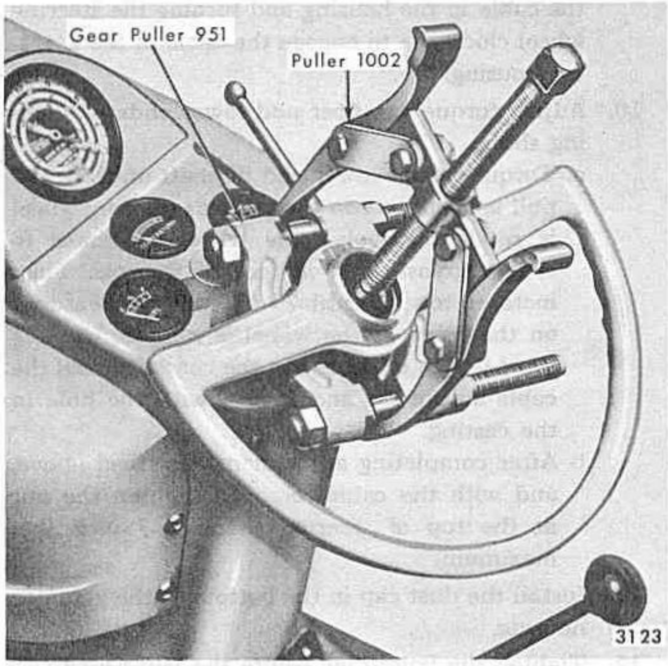

Figure 20—Removing Steering Wheel

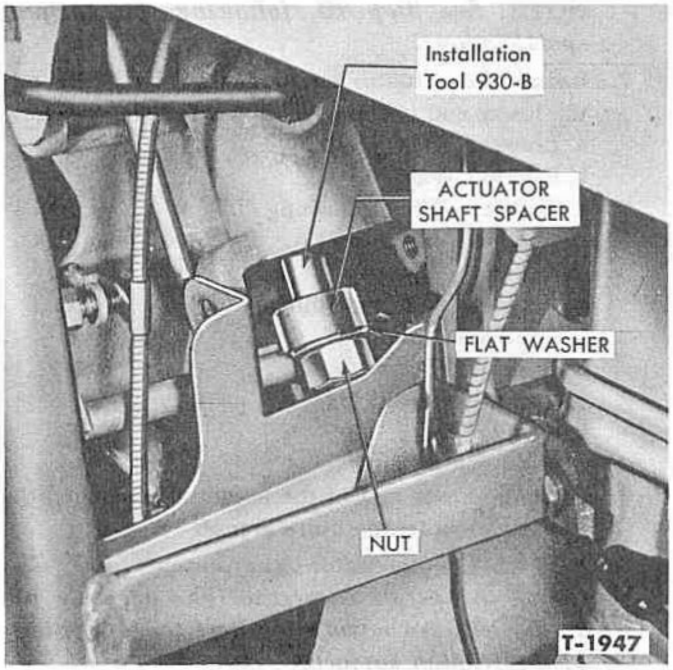

Figure 21—Installing Shaft Spacer on Installation Tool

C. Installation

1. Install the steering shaft spacer in the actuator housing as follows:

   NOTE: *The spacer is a press fit in the housing. In order to install the spacer when the actuator housing is on the tractor, it will be necessary to fabricate an installation tool. A 930-B Puller Leg and a 930-7 Cap and suitable flat washer, spacers, and a hex nut will perform this operation. If these tools are not available, use a suitable rod threaded at each end.*

   a. Insert the rod through the top of the steering column housing.

   b. Install the shaft spacers, chamfer end up, and a flat washer and nut on the lower end of the rod as shown in Figure 21.

   c. Install a suitable spacer, flat washer, and nut at the top of the rod as shown in Figure 22, and draw the shaft spacer into its bore by tightening the nut on top of the rod. Remove the tool and make sure that the bottom face of the spacer is flush with its bore.

2. Coat the bearing surfaces and lower spline of the steering shaft with M-1C-18 low temperature grease.

3. Position the upper thrust washer against the shoulder at the lower end of the steering shaft and install the shaft in the housing from the top.

   NOTE: *The upper thrust washer is the thicker of the two thrust washers used on the shaft.*

4. Install the steering column bearing on the steering column at the top.

5. Position the spring seat, spring, and felt dust seal on the steering column at the top.

6. Install the steering wheel, emblem, and nut and tighten securely. Then, install the steering wheel hub cover.

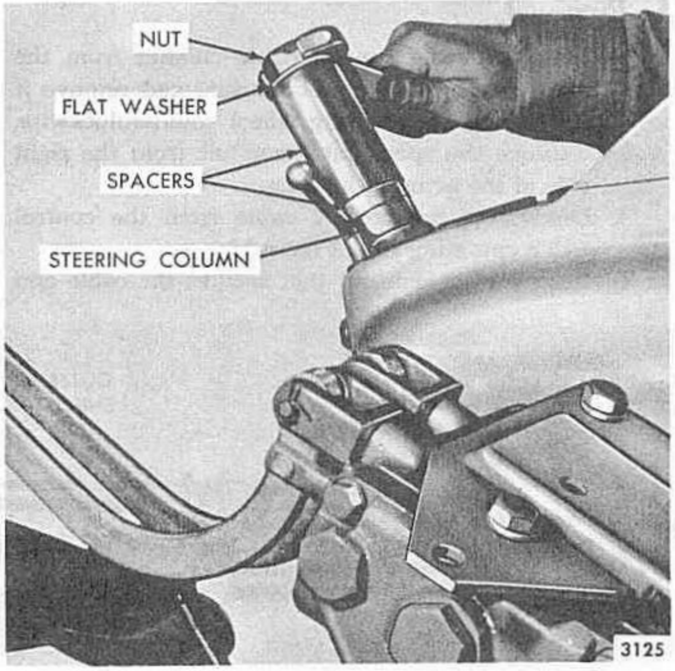

Figure 22—Drawing Shaft Spacer Into Housing

NOTE: *See Step 10, following, for torque specifications.*

7. Install the actuator components, Figure 19, on the lower end of the shaft in the following order:
   a. Lower Thrust Washer
   b. Friction Washer
   c. Actuator Wheel Bushing (Splined end down)
   d. Actuator Wheel
   e. Actuator Wheel Bushing (Splined end up)
   f. Friction Washer
   g. Compression Spring
   h. Spring Seat
   i. Self-Locking Nut
8. Pack the lower end of the actuator housing with M-1C-18 low temperature grease.

   NOTE: *The actuator components are designed to operate in grease. The presence of grease will not adversely affect the operation of the friction surfaces.*
9. Install the actuator cable by inserting the end of the cable in the housing and turning the steering wheel clockwise to engage the cable in the actuator housing.
10. Adjust torque at upper and lower ends of steering shaft:
    a. Torque nut at lower end of shaft until 50 lbs. pull is measured on the cable as steering wheel is rotated. Revolve the wheel six times to reduce grease film on face of washers. Then increase torque until 75 lbs. pull is measured on the cable as the wheel is rotated. Use the short length of cable, not the conduit. Hold the cable stationary and in line with the hole in the casting.
    b. After completing adjustment described above, and with the cable removed, tighten the nut at the top of steering shaft to 7 inch lbs., maximum.
11. Install the dust cap in the bottom of the actuator housing.
12. Tighten the bolts that secure the battery carrier and install the battery.

5. CONTROL CABLE AND CONDUIT ASSEMBLY

CONTROL CABLE—WITHOUT REDUCTION GEAR

A. Removal

1. Disconnect the control cable conduit from the left side of the actuator housing and remove it by turning the steering wheel counterclockwise.
2. Remove the spent cable conduit from the right side of the actuator housing.
3. Disconnect the control cable from the control valve operating stud, Figure 23.
4. Back off the jam nut that secures the cable and conduit assembly to the cable and shield on the power cylinder, Figure 23, and remove it from the shield.
5. Disconnect the cable from the clips that secure it to the tractor.

B. Disassembly

1. Remove the slider tube from the conduit.
2. Remove the cable from the conduit.
3. Inspect all parts for damage and replace as necessary.

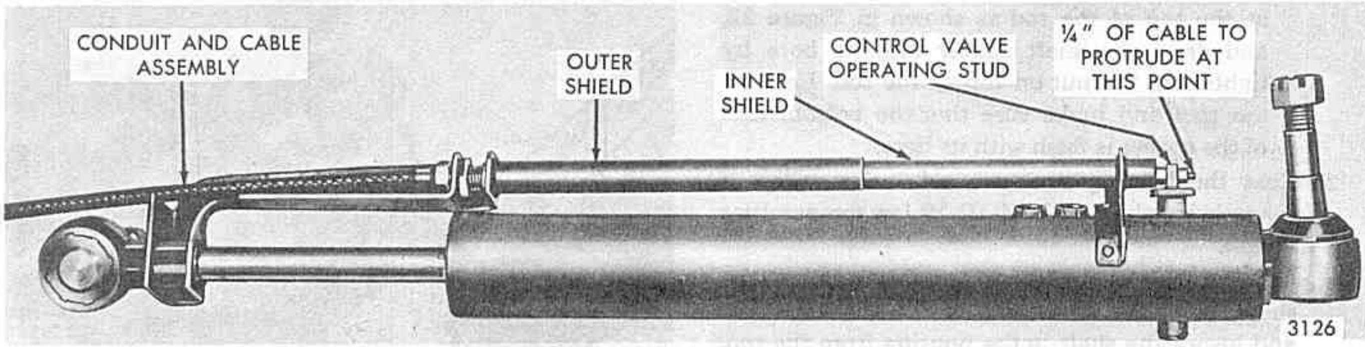
CONDUIT AND CABLE ASSEMBLY
OUTER SHIELD
INNER SHIELD
CONTROL VALVE OPERATING STUD
¼" OF CABLE TO PROTRUDE AT THIS POINT
3126

Figure 23—Adjustment of Control Cable

C. Assembly

1. Coat the cable with M-1C-18 low temperature grease and insert the cable into the conduit. Make sure that the rod end of the cable is at the end of the conduit which attaches to the control valve operating stud.
2. Install the slider tube over the rod end of the cable and thread the tube into the conduit until the shoulder of the tube seats against the conduit.
3. Stake the conduit to the threads of the slider tube.

D. Installation

1. Position the jam nut which secures the conduit to the cable shield in the cable shield bracket, and insert the cable, slider tube, and conduit assembly in the shield.
2. Secure the conduit to the shield bracket by tightening the jam nut.
3. Attach the end of the cable to the control valve operating stud. Adjust the two nuts on the end of the cable so that ¼" of cable protrudes from the nut on the outside of the operating stud, Figure 23.
4. Insert the cable into the actuator housing until it engages the actuator wheel. Turn the steering wheel clockwise until movement of the cable stops and the steering shaft slips on the friction washers.
5. Secure the conduit to the actuator housing.
6. Install the spent cable conduit on the right side of the actuator housing.
7. Attach the conduit to the clips on the tractor.
8. Start the tractor and operate the steering wheel through its full range of travel. Check to see that the front wheels of the tractor turn an equal distance in both directions and that the steering arm on the right side of the tractor does not contact its stops. If any of these conditions do not exist, adjust the position of the cable in the control valve operating stud until proper turning conditions are obtained.

CONTROL CABLE—WITH REDUCTION GEAR

A. Removal

1. Remove the boot from the operating stud.
2. Remove the nut that secures the cable rod to the operating stud.
3. Completely loosen the lower conduit-to-cylinder bracket nut.
4. Disconnect the control cable conduit from the left side of the actuator housing and remove the cable by turning the steering wheel counterclockwise.
5. Disconnect the upper cable conduit from the transmission case bracket.
6. Disconnect the lower cable conduit from the tractor side rail bracket.
7. Disconnect the wheel housing from its support bracket and remove the wheel housing, conduit, and cable as an assembly.

B. Disassembly

1. Remove both the upper and lower conduit extensions.
2. Pull the cables from the conduit and the wheel housing.
3. Remove the four bolts that secure the cover to the wheel housing and remove the cover and the wheel.
4. Inspect all parts for damage and replace as necessary.

C. Assembly

1. Place the wheel in the wheel housing, position the cover to the housing, and secure with the four bolts.
2. Coat the cables with M-1C-18 low temperature grease and insert them into the conduit and through the wheel housing. Make sure that the rod end of the cable, which attaches to the control valve operating stud, is installed in the lower conduit.
3. Install the slider tube over the rod end of the cable and thread the tube into the conduit until the shoulder of the tube seats against the conduit.
4. Stake the conduit to the threads of the slider tube.
5. Install the lower conduit extension.

D. Installation

1. Place the wheel housing and the cable and conduit assembly in their installed position, Figure 24, and attach the wheel housing to its support bracket. Make sure the upper conduit assembly and the lower conduit assembly extension is passed through the holes in the left side member bracket.
2. Position the ⅞"—14 nut and lock washer in the outer shield and bracket assembly into the outer and inner shield and bracket assemblies until the actuating cable rod passes through the power steering cylinder control valve operating stud, Figure 23. Secure the actuator cable and conduit assembly to the outer shield and bracket assembly with the ⅞"—14 nut and lock washers.

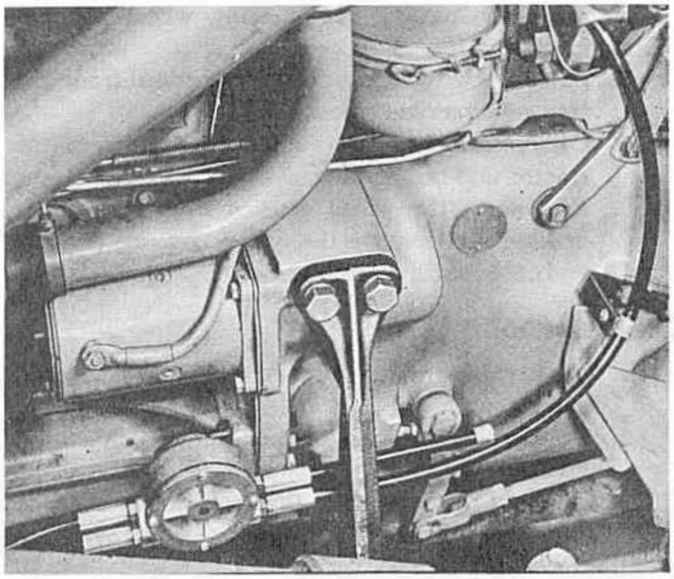

Figure 24—Control Cable Reduction Gear Assembly Installed

3. Thread the remaining ¼″–28 nut onto the actuating cable rod and tighten both nuts against the faces of the actuator stud, then install the boot.
4. Be sure the parking brakes are set and locked; be sure the tractor is out of gear, then start the engine. Grasp the upper end of the upper actuating cable and slowly pull the cable as far out as possible. This will turn the tractor wheels to a full right turn position. Keep pull pressure on the cable and with a rule, measure the distance the cable extends from the face of the wheel housing, as shown in Figure 25. The cable should extend between ⅛″ and ⅜″. If not within these limits, thread the cable either in or out as required, by turning it right or left. Stop the engine and install the upper conduit extension.

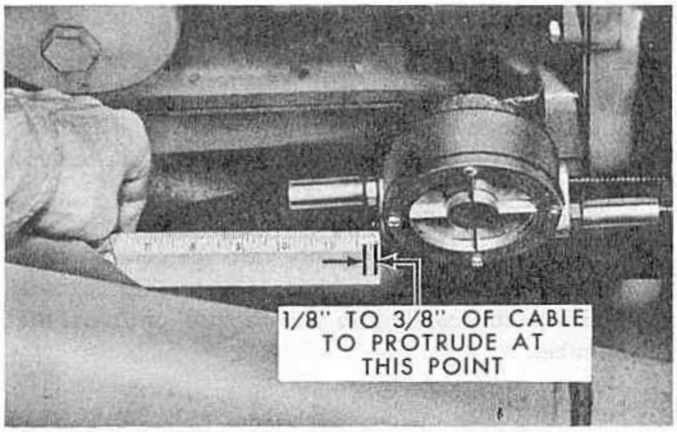

Figure 25—Adjusting the Upper Cable Extension

5. Insert the upper end of the upper cable into the actuator housing and thread it in by turning the steering wheel to the right until the threads of the upper cable conduit meet the threads in the actuator housing. Start the conduit threads by hand, then tighten with a $\frac{9}{16}$″ end wrench.
6. Attach the upper cable conduit to the transmission case bracket.
7. Attach the lower cable conduit to the tractor side rail bracket.
8. Start the engine and operate the steering wheel through its full range of travel. Check to see that the front wheels of the tractor turn an equal distance in both directions and that the steering arm does not contact the stops on the right side of the axle. If the wheels do not turn an equal distance, or if the steering arm contacts a stop at the full range travel in either direction, adjust the position of the cable in the control valve operating stud to obtain proper movement of the front wheels.

6. TROUBLE SHOOTING

Trouble	Possible Cause	Corrective Action
Slow Steering Action or No Steering Action	Improper oil level in reservoir	Check reservoir for proper level.
	Pump output low	Check for dirt in the system or for burrs on the flow spool or the valve liner.
	Air in system	Check all tube connections and fittings for leaks. Tighten connections. Replace the fittings if necessary. Bleed air from the system.
	Tubing or hose damaged	Replace tubing or hose that is visibly damaged.
	Pump drive belt loose or slipping	Adjust the belt to obtain ¼″ deflection, halfway between the pulleys, under 15 to 20 lbs. pressure.

TROUBLE SHOOTING CONT'D.

Trouble	Possible Cause	Corrective Action
Slow Steering Action or No Steering Action	Pump flow valve spool stuck in open position	Check for dirt in the system or for burrs on the flow valve spool or the valve liner.
	Weakened or broken pump relief valve spring	Replace the relief valve assembly.
	Bolts loose in pump	Tighten the bolts to specified torque.
	Pump relief valve leaking	Check for dirt or nicks on the relief valve seat. Replace the relief valve assembly. Clean the flow valve spool spring screen.
	Weakened or broken pump flow control valve spring	Check the spring tension. Replace it if weak.
	Pump flow control valve assembly defective	Disassemble the flow control valve assembly. Check for scratches or scoring on the control valve spool lands and in the control valve bore. Replace the entire assembly if defects are found.
	Leaking power cylinder	Replace the piston rod seal or the power cylinder assembly.
Hard or Jerky Steering Toward End of Full Left or Full Right Turn	Pump drive belt loose	Adjust the belt to obtain ¼" deflection, halfway between the pulleys, under 15 to 20 lbs. pressure.
Pump Noisy	Improper oil level in reservoir	Check for proper reservoir level.
	Air in system	Check all tube connections for leaks. Tighten the connections. If necessary, replace fittings.
	Pump pulley loose	Make sure the key is properly inserted in the keyway. Tighten the pulley retaining bolt to specified torque.
	Pump defective	Replace the pump.
	Water in oil	Drain the oil from the system and replace.
Loose Steering	Improper preload on actuator shaft friction spring. (Industrial Tractors)	Replace the spring.
	Fluid level low	Fill the reservoir to proper level.
	Excessive clearance between ball stud and ball stud seats	Remove and disassemble the control valve sleeve and flange assembly. Check the tension of the ball stud spring. Replace the spring if defective.
	Improper cable adjustment (Industrial Tractors)	Reset the cable adjustment.
Steering Wheel pulls to One Side	Improper cable adjustment (Industrial Tractors)	Reset the cable adjustment.
Front Wheels Will Not Remain in Straight Ahead Position or Other Position Selected by Operator	Control Valve spool sticking	Check for dirt in the system or for burrs on the flow valve or the valve liner.
	Improper cable adjustment (Industrial Tractors)	Reset the cable adjustment.
Front Wheels Surge When Turning	Control Valve spool sticking	Check for dirt in the system or for burrs on the flow spool or the valve liner.
	Excessive internal leakage in cylinder assembly	Replace the piston rod seal.

TROUBLE SHOOTING CONT'D.

Trouble	Possible Cause	Corrective Action
Binding Condition	Interference at the sleeve, dust shield, and ball stud connection (Row Crop Tractors)	Check the ball stud for a groove caused by rubbing against the side of the slot in the sleeve and flange assembly. Replace the ball stud if damaged. Also, check the dust shield for possible cramping on the sleeve assembly. Replace the shield if it appears to hamper the free movement of the ball stud.
Steering Chatter	Piston rod end play (General Purpose Tractors)	Check the rubber insulators for excessive wear or damage. Replace them if defective. Check the cylinder rod nut for proper tightness (20-25 ft. lbs.)
	Side rail rod support loose (Row Crop Tractors)	Tighten the bolts that secure the piston rod support to the side rail of the tractor.
	Pump belt loose or slipping	Adjust the belt to obtain ¼″ deflection, halfway between the pulleys, under 15 to 20 lbs. pressure.

7. SPECIFICATIONS

Pump

Capacity	7.5 gpm @ 1250 engine rpm and 1200 psi
Type	Roller Vane
Drive	Belt, 2:1 ratio with engine rpm
Max. Operating Pressure	1550 psi

Cylinder

Type	Integral with valve, 11.6″ stroke

Steering Gear

Steering Housing Actuator Adjustment	25 to 30 lbs. pull at Steering Wheel

Torque Limits	Ft. lbs.
Pump Flow Control Valve Fitting	30-35
Pump Cover to Pump Body Bolts	20-25
Pump Reservoir Retainer Stud	30-35
Pump Pulley Retaining Bolt	15-20
Power Cylinder Piston Rod Guide Assembly	200-230

8. SPECIAL TOOLS

The following tools will be helpful in removing or repairing the various components of the power steering system.

Tool Number	Description
930-B	Puller Leg
930-7	Cap
1002	Puller
951	Gear Puller

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS, AND TIRES

Chapter

II

Front Axle

Section

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2	Row Crop Front Axles	346
3	Row Crop Pedestal	348
4	Row Crop Wide Adjustable Front Axle	353
5	Industrial Front Axle	355
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The front axle on "General Purpose" tractors consists of a center axle assembly, right axle half, left axle half, radius rods, steering spindle arms, front support, and right and left spindle assemblies. The axle halves are designed as housings or supports for the spindle assemblies. On "Row Crop" tractors, a pedestal assembly accommodates the front wheel mounting and serves as a support for the front end. This closed pedestal houses the steering sector gear and shaft assembly. The pedestal is bolted to the engine side rails. An adapter is available for "Row Crop" tractors to convert them into a wide adjustable four wheel model. The "Industrial" front axle is a non-adjustable type and is secured in the yoke of the front support member by a solid axle pin.

1. GENERAL PURPOSE FRONT AXLE– STANDARD AND HEAVY DUTY

RADIUS ROD

A. Removal

Refer to Figure 1 for an exploded view of the "General Purpose" front axle.

1. Remove two nuts and lock washers and remove the radius rod ball cap at the transmission, Figure 2.
2. Remove the nut and lock washer from the radius-rod-to-axle bolt and drive the bolt out of the center axle with a soft mallet. If the bolt is seized, drive it out with a heavy hammer and punch.

   IMPORTANT: ***Never use heat to remove axle bolts.***
3. Remove the radius rod from the tractor.

   NOTE: ***On tractors equipped with power steering assist, refer to Page 298, to remove the power cylinder.***

B. Installation

1. Inspect the radius rod for a fractured or sprung condition. A bent radius rod is an indication that the axle is sprung. Check the ball joint for wear or scoring.
2. Position the radius rod over the center axle and insert the rod-to-axle bolt, using a new bolt if the original bolt was loose or threads were damaged. Tighten to 75-135 ft. lbs.
3. Coat the ball joint lightly with grease and secure in place with the ball cap, lock washers, and nuts.
4. Tighten the nuts to 45-50 ft. lbs.

AXLE HALF

A. Removal

1. Use a suitable jack or hoist to support the front end of tractor.
2. Remove the wheel and hub as described on Page 369.
3. Remove the spindle arm nut, lock washer, and bolt. Remove the spindle arm from the spindle assembly, Figure 3, with Puller 1001 and Step Plate 630-2.

   NOTE: ***If the spindle assembly seals or bearings are to be replaced and the axle half is not***

damaged, omit step 4 and proceed to "B" Disassembly.

4. Remove two nuts and lock washers and separate the axle half from the center axle.

B. Disassembly

1. Remove the Woodruff key and seal, and pull the spindle assembly from the axle half, Figure 4.
2. Secure the axle half in a vise.
3. Remove the upper and lower bushing with an arbor press or suitable puller. When removing bushings, use extreme care so as not to enlarge the bore.

   NOTE: ***On heavy duty front axles, the lower bushing should be removed by using a "Cape" chisel to collapse the bushing.***
4. Remove the bearing assembly.

C. Cleaning and Inspection

1. Clean all metal parts in solvent.
2. Inspect the axle half for fracture or sprung condition.

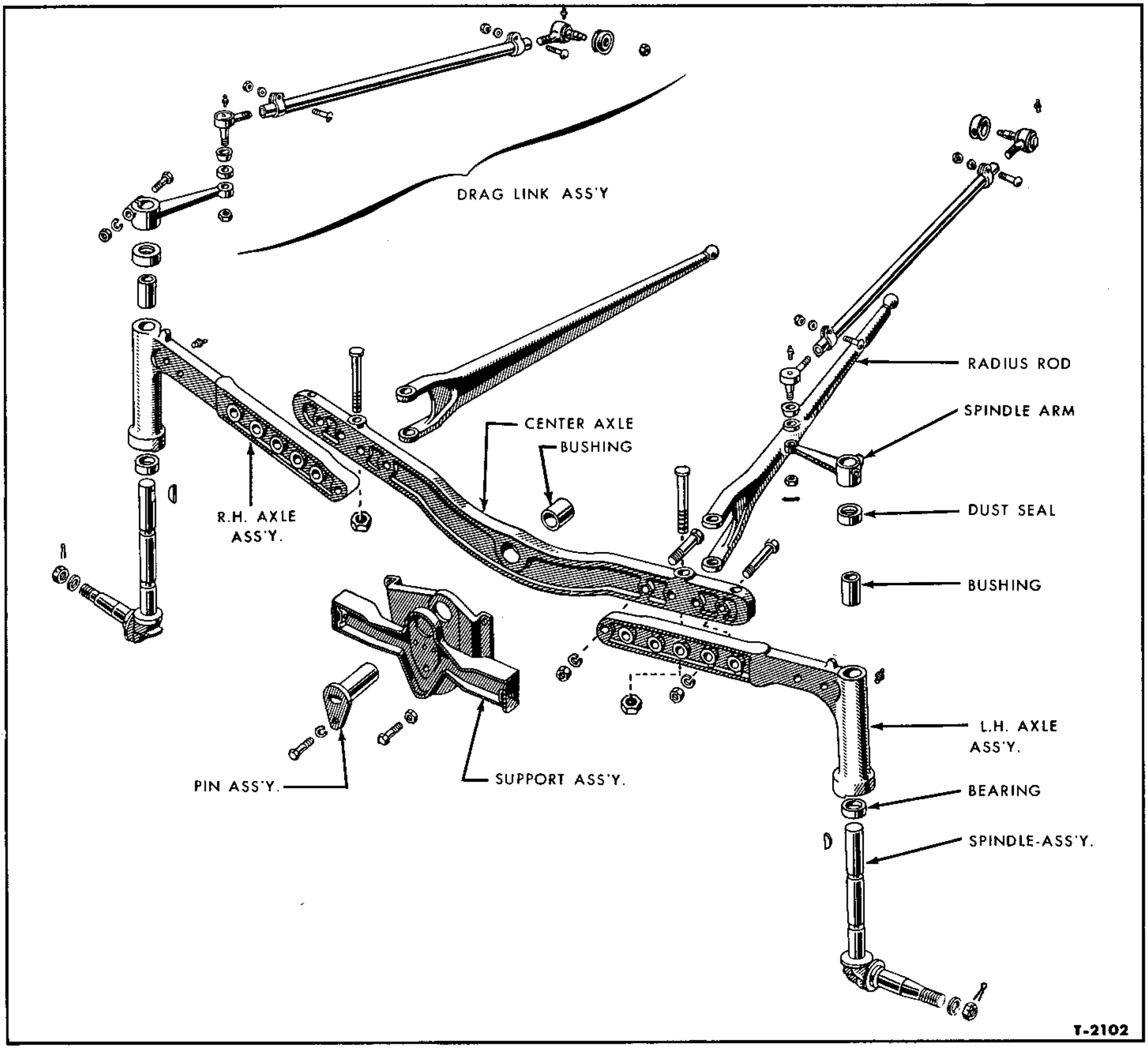

Figure 1—General Purpose Front Axle

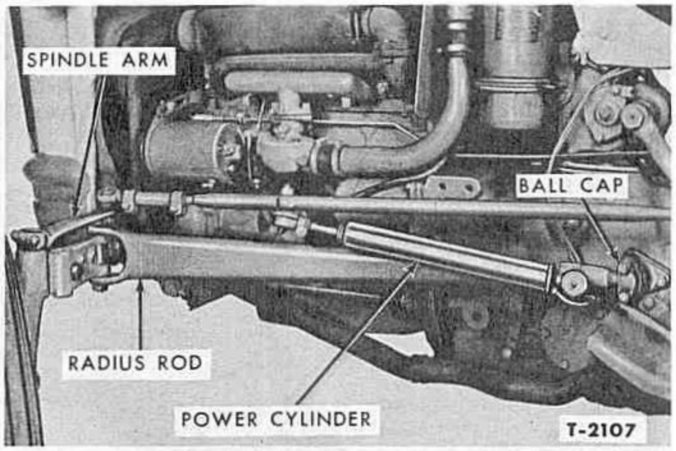

Figure 2—Removing Radius Rod

3. Inspect the spindle for galling, burrs, or sprung condition.
4. Inspect the dust seal and bearing for signs of wear.

D. Assembly

1. Install the axle half upper and lower bushing, Figure 5, with Bushing Driver T-807 and an arbor press. Be sure the bushings are pressed all the way in the housing.

   NOTE: ***On heavy duty front axles, the lower bushing should be installed with Bushing Driver T-808 and a No. 815 Driver Handle. Drive the bushing in until the edge of the bushing is flush with the lower end of the chamfer in the housing, as viewed from the thrust bearing end of the housing.***
2. Place the bearing in the bore.
3. Insert the spindle assembly in the axle half housing.
4. Install the Woodruff key and upper seal.

E. Installation

1. Position the axle half on the center axle and install the bolts, lock washers, and nuts; tighten to 135-150 ft. lbs.
2. Install the spindle arm bolt, lock washer, and nut; tighten to 60-70 ft. lbs.
3. Install the wheel and hub as described on Page 369.

FRONT AXLE SUPPORT

A. Removal

1. Use a suitable jack or hoist to support the front end of the tractor.
2. Remove two hex head cap screws and two thumb screws, and remove the lower front hood panel.
3. Remove the radiator as described on Page 152.
4. Remove the cotter pins and castellated nuts, and separate the drag links from the spindle arms.
5. Disconnect the radius rods at the center axle or at the transmission.
6. Remove the four nuts and lock washers securing the front support to the engine and roll the axle and support away from the tractor, as shown in Figure 6.

   NOTE: ***Effective with Tractor Serial No. 41889, the front axle pin used on "General Purpose" tractors was replaced with a threaded axle pin.***

Threaded Axle Pins:

a. Remove the bolt and lock washer securing the locking flange to the front support and remove the snap ring and locking flange, Figure 7.

b. Remove the threaded pin by turning it counterclockwise. A piece of bar stock ¾" x 2" can be

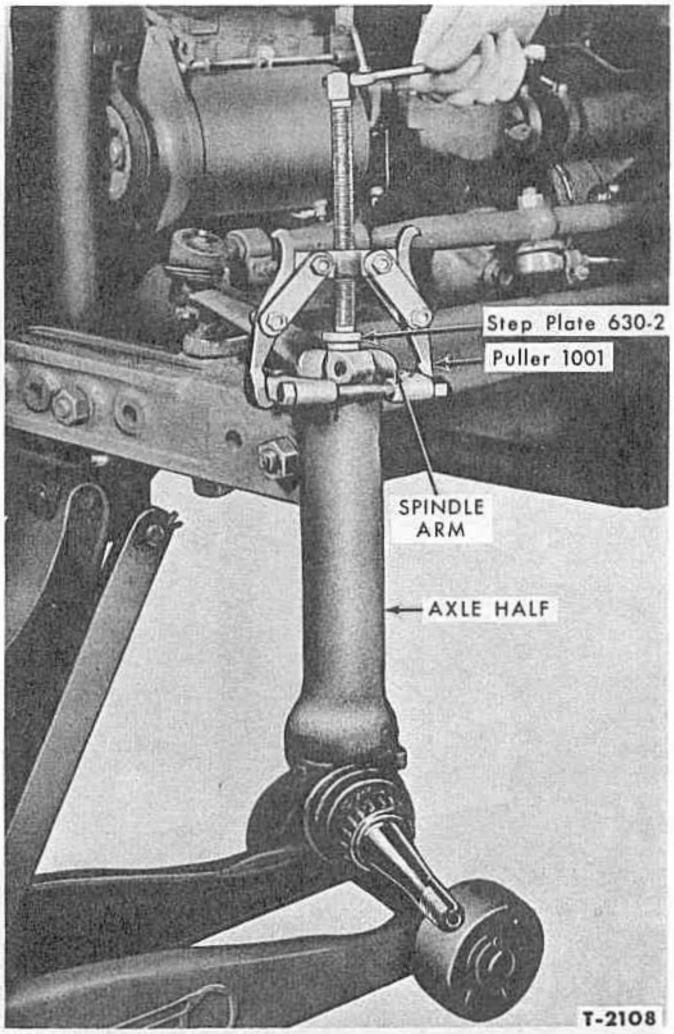

Figure 3—Removing Spindle Arm

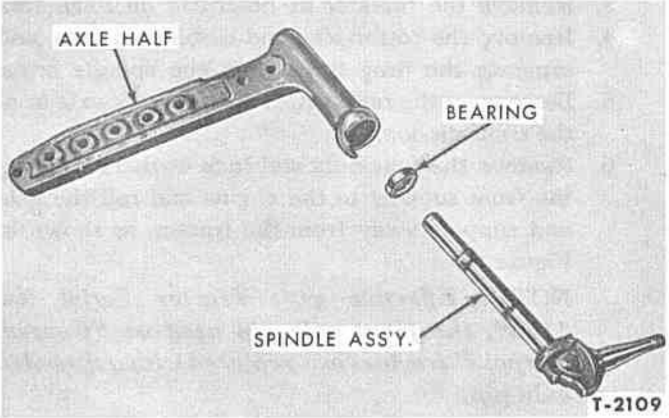

Figure 4—Axle Half—Disassembled View

used as a special tool. Insert the end of the bar between the ears of the pin and use a wrench to turn the tool.

NOTE: *The heavy duty front axle has a hex head.*

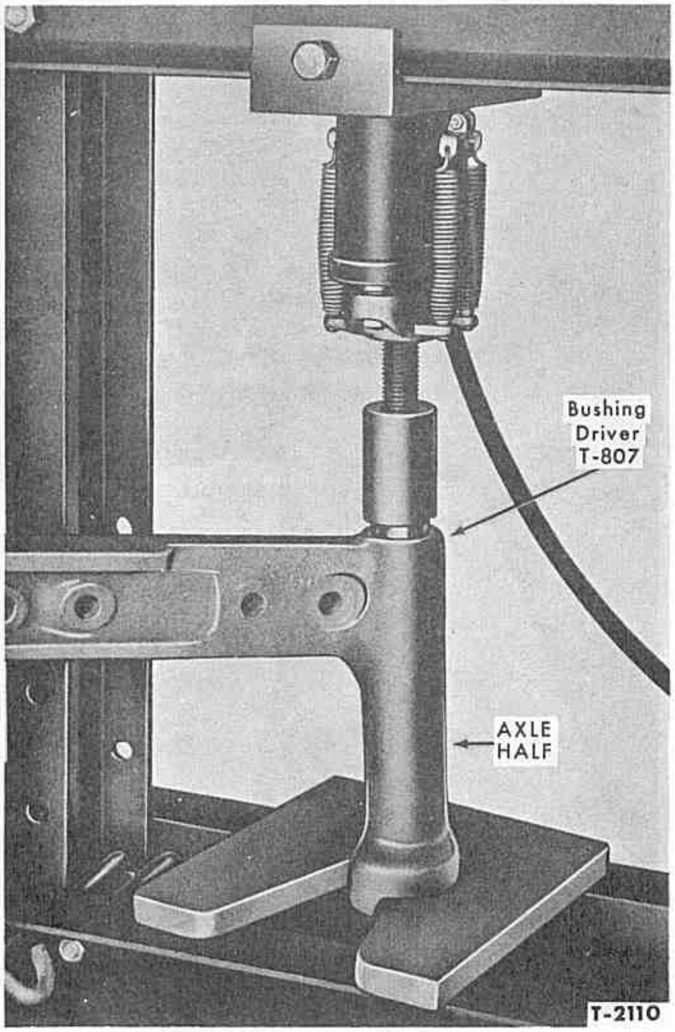

Figure 5—Installing Axle Half Bushing

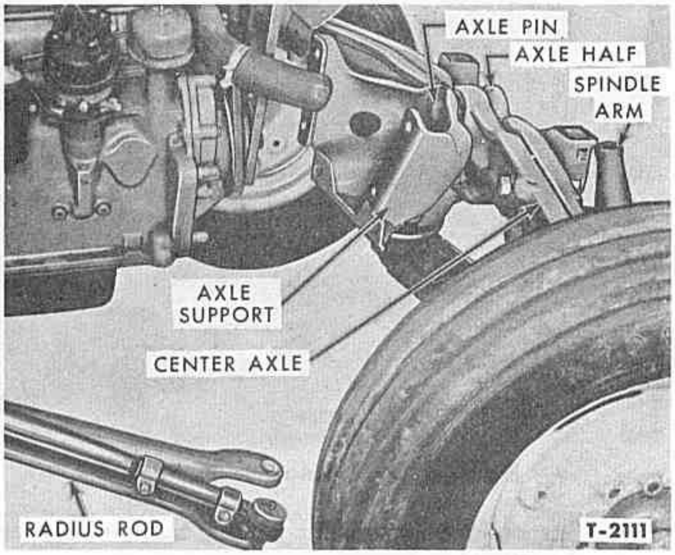

Figure 6—Removing Axle Assembly

Non-Threaded Axle Pins:

a. Remove the axle pin retaining screw and lock washer.

b. Use a slide hammer with a suitable adapter and pull the pin as shown in Figure 8.

7. Remove the front axle support.

B. Cleaning and Inspection

1. Clean all metal parts in cleaning solvent.
2. Inspect the support for cracks, distortion, or other signs of fatigue.

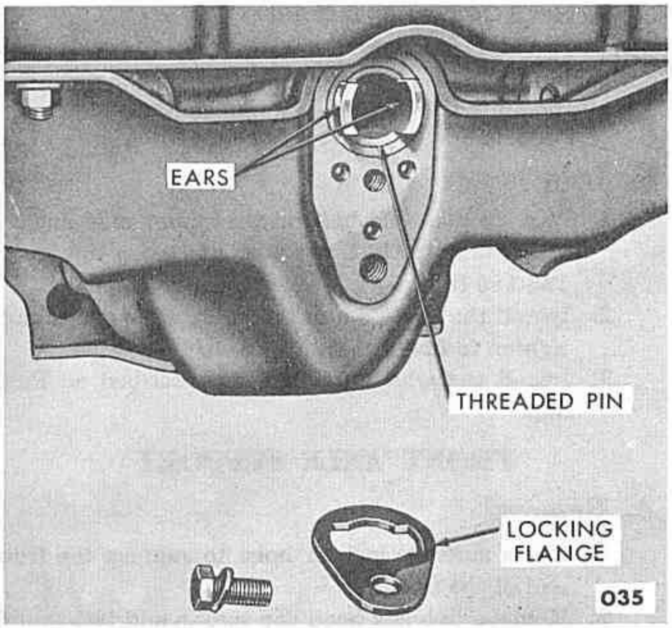

Figure 7—Threaded Axle Pin

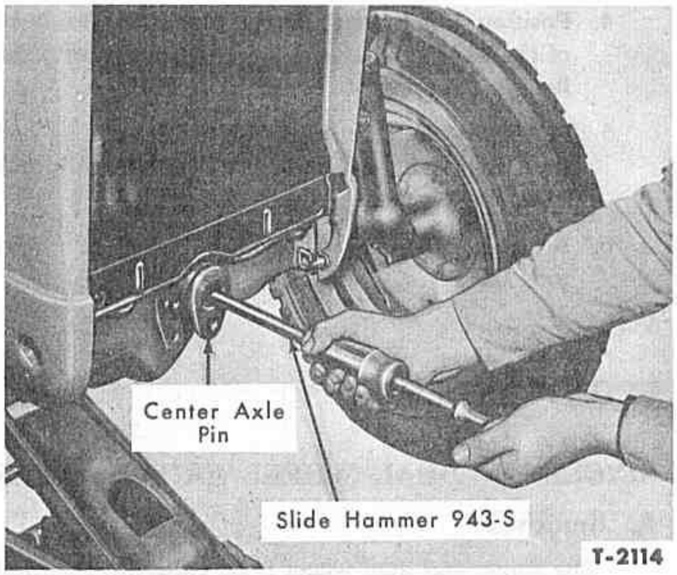

Figure 8—Removing Non-threaded Axle Pin

3. Inspect the axle pin for burrs and galling.

C. Installation

1. Position the support on the axle assembly and, depending upon type of center pin, drive or screw the pin into the center axle and support assembly.
2. Secure the center pin as appropriate with screw and lock washer or with locking flange, bolt, and lock washer.
3. Position the axle and support assembly on the tractor. Install and tighten the four support-to-engine nuts and lock washers to 135-150 ft. lbs.
4. Attach both radius rods at the transmission.
5. Attach the right and left drag links to the spindle arms.
6. Install the radiator as described on Page 152.
7. Install the grille with four attaching screws.

CENTER AXLE

A. Removal

On tractors with front mounted loading equipment, it is necessary to remove the entire front axle assembly from the tractor before the center axle can be removed. For complete front axle removal, refer to Front Axle Support Removal, Page 343. The following procedure pertains to tractors without such special front mounted equipment.

1. Use a suitable jack or hoist to support the front end of the tractor.
2. Remove the nut and lock washer from each radius-rod-to-axle bolt and drive each bolt out of the center axle with a soft mallet.
3. Remove two hex head cap screws and two thumb screws and remove the lower front hood panel.
4. Remove the radiator as described on Page 152.
5. Remove the front axle pin. Refer to front axle support removal, step 6, on Page 343.
6. Remove the four axle-half-to-center axle nuts, lock washers, and bolts.
7. Using the spindle arms as pivot points, position the axle halves aside to provide clearance for withdrawing the center axle.
8. Withdraw the center axle, Figure 9, from either side of the tractor.

   NOTE: *On heavy duty front axles, a spacer bushing is incorporated in lieu of a press fit bushing. Slide the center axle forward and remove the axle and bushing sideways from the support assembly.*

B. Repair

1. Check the bushing for scoring.
2. Check the axle for cracks and alignment.
3. If the bushing is damaged, remove it with an arbor press or suitable puller; and install a new bushing.

C. Installation

Standard Axle:

1. Position the center axle in the axle support.
2. Position the axle halves and install the bolts, lock washers and nuts finger tight.
3. Install the front axle pin.
4. Install the radiator and grille.
5. Attach the radius rods to the axle and tighten the nuts to 75-135 ft. lbs.
6. Tighten the axle bolts to 135-150 ft. lbs.

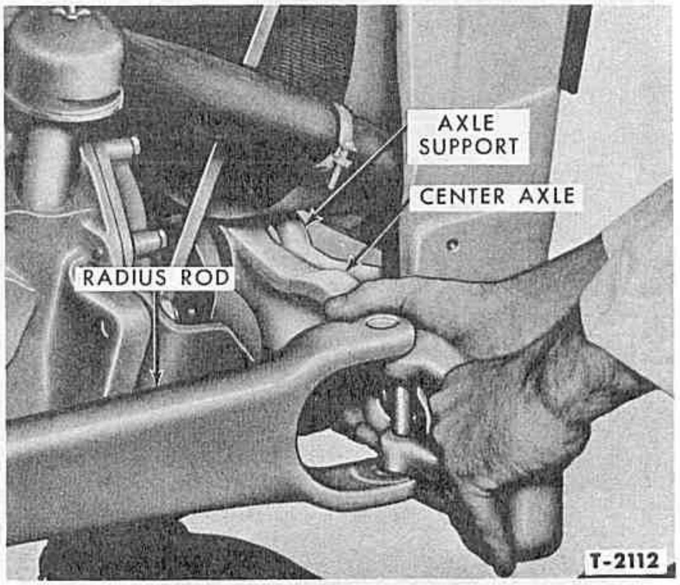

Figure 9—Removing Center Axle

Heavy Duty Axle:

1. Place the spacer bushing approximately midway in the center hole of the center axle.
2. Working from either side of the tractor, slide the center axle section into position.
3. Thread the axle pin into the rear support and tighten it to 200 ft. lbs.
4. Position the locking flange over the hex head of the pin and align the flange bolt hole with the hole in the support.
5. Place a washer between the locking flange and the front support, and install bolt and lock washer.
6. Attach the axle halves, radiator, grille, and radius rod.

2. ROW CROP FRONT AXLES

Three interchangeable front axles are available for the new pedestal on "Row Crop" tractors. These are the single wheel front axle, dual wheel front axle, and wide adjustable front axle. The single and dual wheel axles are an integral part of their respective spindle assemblies, which are mounted to the pinion shaft located at the bottom of the pedestal, Figure 10. The wide adjustable front axle is attached to an axle support, which bolts to blind tapped holes in the bottom of the pedestal body, Figure 10. The following procedures contain information on removing and installing the three front axles. The single and dual wheel front axles cannot be disassembled or repaired. For disassembly and repair of the wide adjustable front axle, refer to the appropriate section.

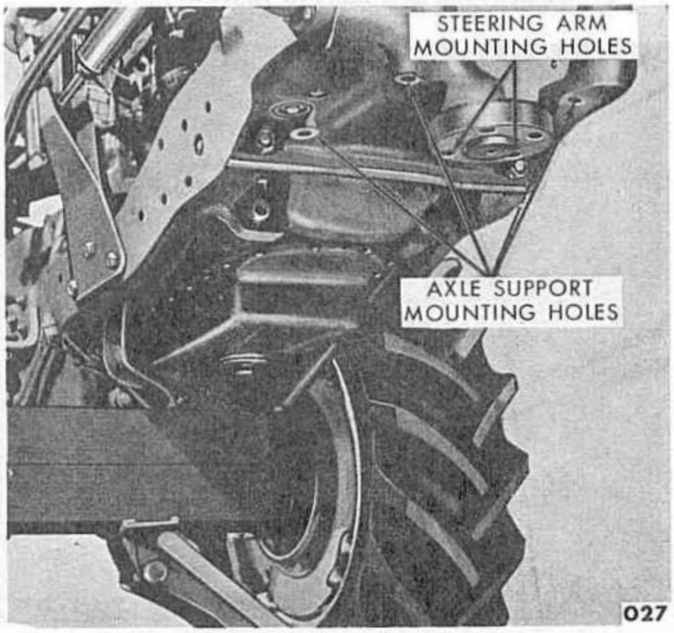

Figure 10—Wide Adjustable Front Axle Attaching Points

SINGLE OR DUAL WHEEL FRONT AXLES

A. Removal

The single and dual wheel front axles are removed in the same manner except that the wheel and tire of the single front wheel axle must be removed to provide access to the mounting bolts.

1. Use a suitable jack or hoist to support the front end of the tractor and set the rear wheel parking brake.
2. Position the steering wheel in the straight ahead position.
3. Remove four bolts securing the spindle assembly to the pinion shaft pad.

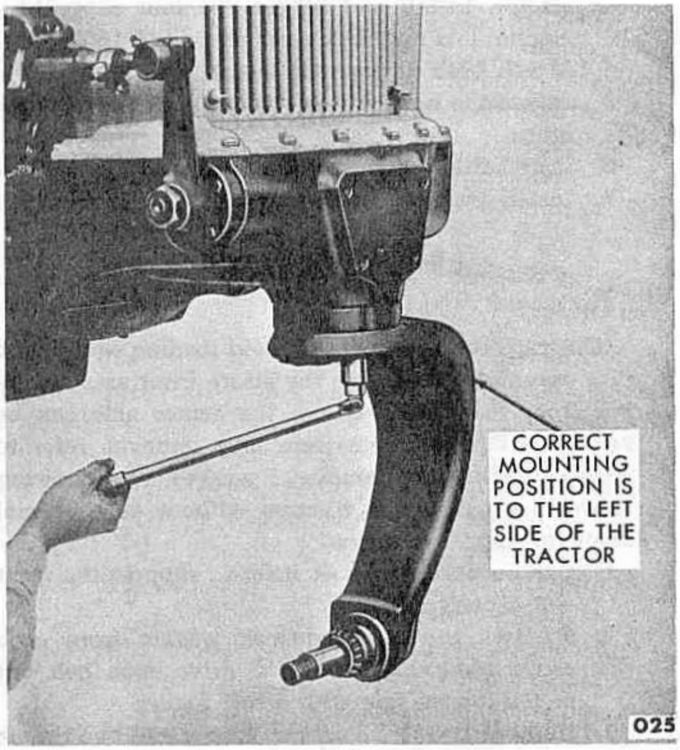
CORRECT MOUNTING POSITION IS TO THE LEFT SIDE OF THE TRACTOR
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Figure 11—Installing Single Wheel Front Axle

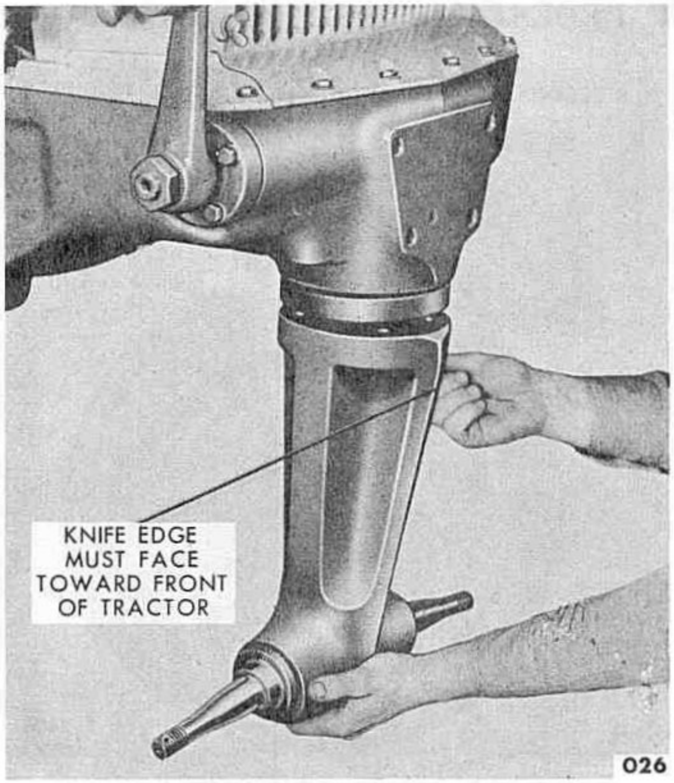


Figure 12—Installing Dual Wheel Front Axle

B. Installation

1. With the front end of tractor jacked up to sufficient height, align the spindle assembly with the holes of the pinion shaft pad. Figure 11 shows the correct position of the single wheel front axle and Figure 12 shows the correct position of the dual wheel front axle.

   IMPORTANT: ***If either front axle is assembled in reverse, the axle caster will be affected.***

2. Install the mounting bolts and tighten them to 135-150 ft. lbs.

WIDE ADJUSTABLE FRONT AXLE

A. Removal

1. Using a suitable jack or hoist, raise the tractor front end high enough to take the weight off the front wheels and place a jack stand under the radius rod at the support connection as shown in Figure 13.

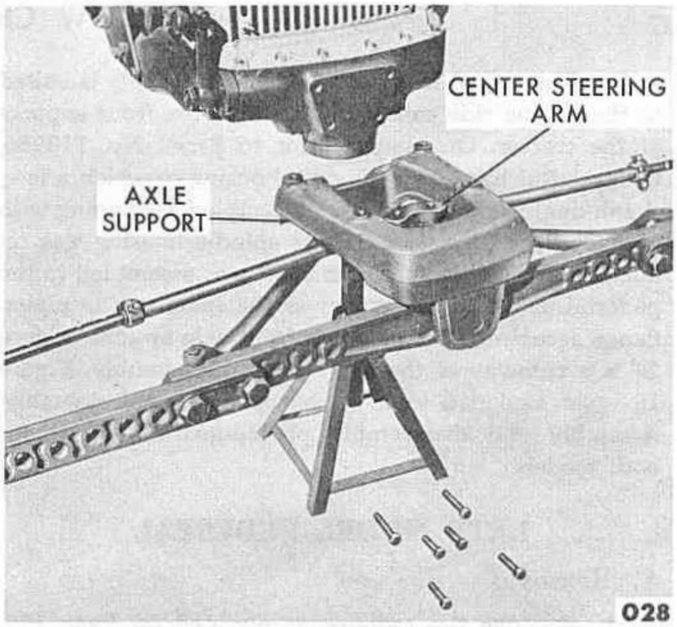


Figure 13—Installing Wide Adjustable Front Axle

2. Remove two short bolts securing the steering arm to the pinion shaft pad.
3. Remove four bolts securing the axle support to the bottom of the pedestal.
4. Raise the tractor high enough to clear the axle support and roll the axle assembly away from the tractor.

B. Installation

1. Raise the front end of the tractor high enough to clear the axle support and roll the axle assembly into position. Stabilize the axle assembly with a jack stand as shown in Figure 13.
2. Align the four axle support bolt holes with the holes in the bottom of the pedestal and lower the tractor until contact is made.
3. Install the axle support to pedestal bolts and tighten them to 150-180 ft. lbs.
4. Move the front wheels to align the steering arm bolt holes with the two rear holes in pinion shaft pad.
5. Install the short bolts and tighten them to 150-180 ft. lbs. Install two plugs in the front holes in the pinion shaft pad and tighten them to 130-150 ft. lbs.

3. ROW CROP PEDESTAL

On "Row Crop" tractors, a pedestal assembly is bolted to the engine side rails and serves as the front support of the tractor. On models prior to Serial No. 110986, the pedestal had a long spindle housing to which a long shank dual wheel spindle was assembled. Beginning with Tractor Serial No. 110986, the spindle housing was reduced in height and a pinion shaft was assembled to the pedestal in the same manner as the spindle. The pinion flange accommodates all three front axle options. Figure 14 is a cutaway of the early pedestal assembly. Figure 15 is an exploded view of the new pedestal assembly. Assembly and disassembly procedures are given for both models.

LATE MODEL PEDESTAL

A. Removal

1. Remove the radiator as outlined on Page 152.
2. Remove the front axle as described under Row Crop Front Axles, Page 346.
3. Remove the nut and lock washer securing the steering arm to the sector shaft and remove the steering arm using Puller 1002.

   NOTE: ***On tractors equipped with power steering, support the power cylinder and control valve by securing it to the headlamp.***
4. Remove the eight bolts from the pedestal cover and remove the cover and gasket. Discard the gasket.
5. Place a container under the pedestal and remove the recessed drain plug located on the machined front face of the pedestal and allow the oil to drain.
6. Remove six nuts, washers, and bolts securing the pedestal assembly to the engine side rails, and pull the pedestal away from the tractor. Be sure the pedestal is firmly supported when it is removed.

B. Disassembly

1. Remove the four bolts and lock washers from the sector shaft cap and remove the cap, shim pack, and shaft seal, Figure 15.

   NOTE: ***Effective with Tractor Serial No. 18122, a flanged seal is used. This seal bolts to a new cap rather than the press fit of old cap and seal.***
2. Remove the pinion shaft cotter pin and retaining nut. Drive the pinion shaft down through the pedestal using a soft mallet.

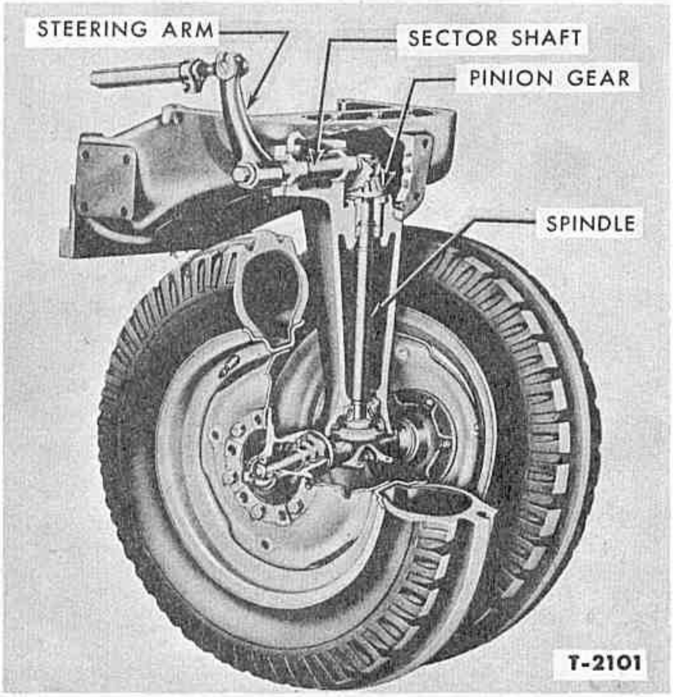


Figure 14—Pedestal Assembly—Early Model

3. Remove the tapered roller bearing from the pinion shaft with Puller 951.
4. Rotate the sector shaft until the pinion gear becomes disengaged. Lift the pinion gear out through one of the holes in the top of the pedestal housing.
5. Remove the sector shaft (gear end first) in the same manner as the pinion gear.
6. Drive two sector shaft bushings from the sector shaft bore using Tool NCB-3179, as shown in Figure 16.
7. Remove the small pinion shaft bearing from the bearing cup at the top of the pinion shaft bore. This bearing is a slip fit and can be removed by hand.
8. Using the special tools shown in Figures 17 and 18, remove the small bearing cup from the top of the pinion shaft bore and the large bearing cup from the bottom of the pinion shaft bore.
9. Drive the pinion shaft seal out of the bore using a wood block and hammer.

C. Pedestal Repair

1. Clean all parts in cleaning solvent.
2. Inspect the pedestal housing for cracks, distortion, or other serious defects.
3. Inspect the bearings, bearing cups, and seals for cracks or serious galling.

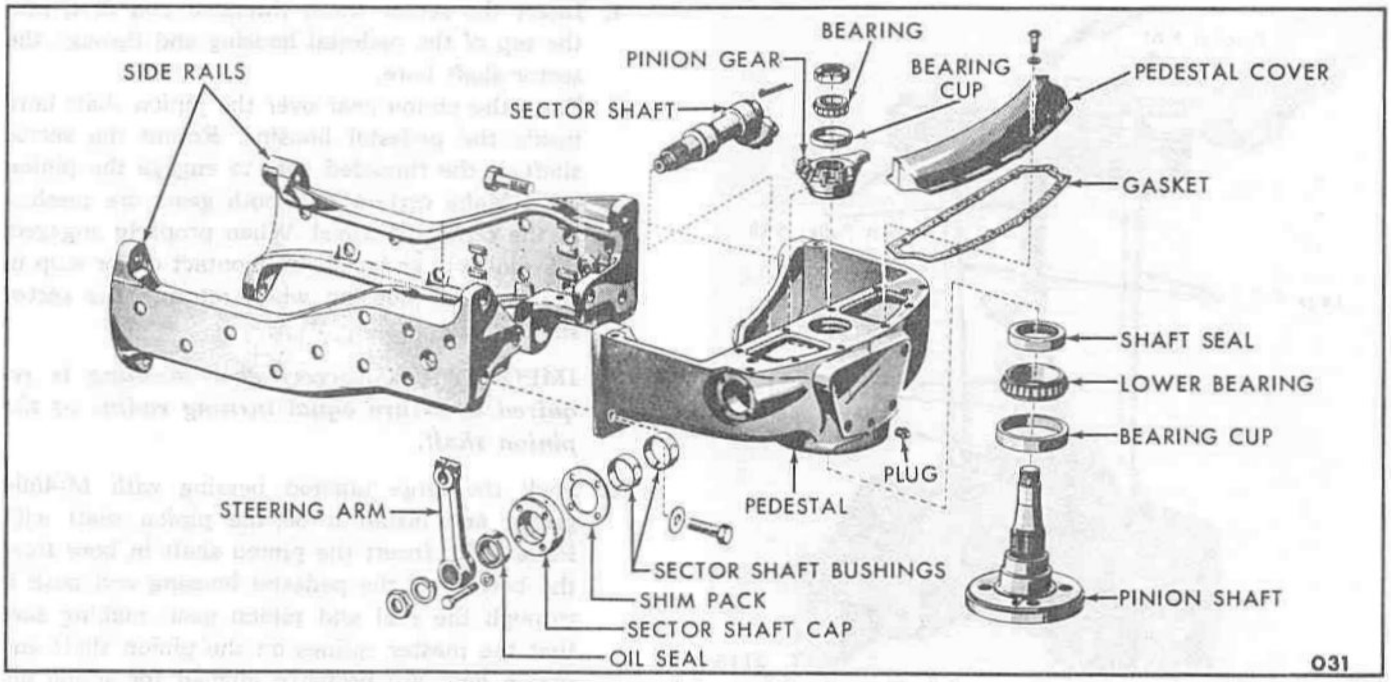


Figure 15—Pedestal Assembly—Late Model

4. Inspect the gears for cracks or missing teeth.
5. Inspect all bolt holes for elongation or cracks.
6. Inspect the bushings for scoring or wear.

D. Pedestal Reassembly

1. Place the pinion upper and lower bearing cups in the pinion shaft bore. Tap each cup gently around the edge until firmly seated. Use a brass rod or a wood block and hammer to seat the bearing cups.

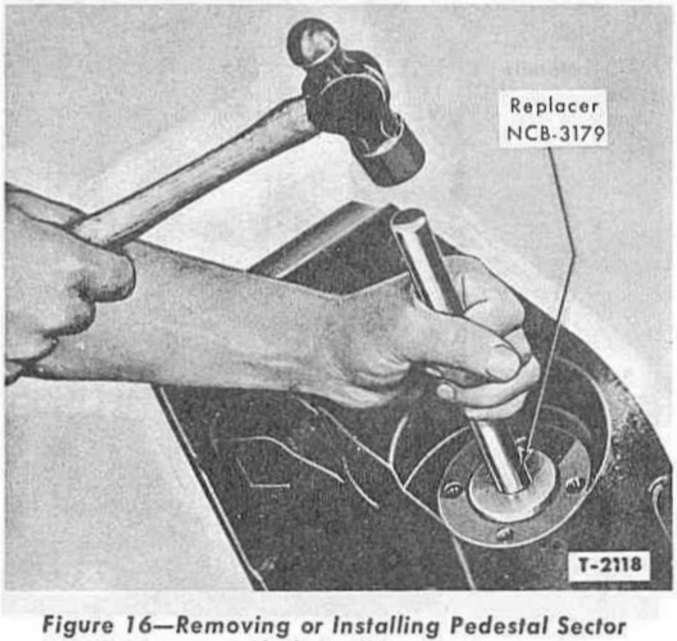


Figure 16—Removing or Installing Pedestal Sector Shaft Bushings

2. Insert a new oil seal through the lower bearing cup in the pinion shaft bore. Use a hammer and wood block to position the seal. There must be 1.48" clearance between the bottom of the seal and the machined face of the shaft bore. Seal positioning is best accomplished by laying a straight edge across the face of the bore, as shown in Figure 19, and using a ruler to measure

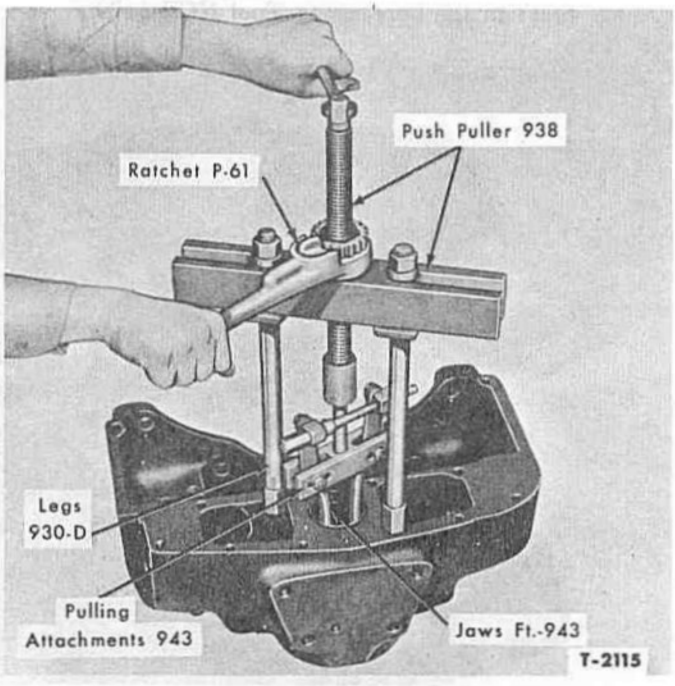


Figure 17—Pulling Pinion Shaft Upper Bearing Cup

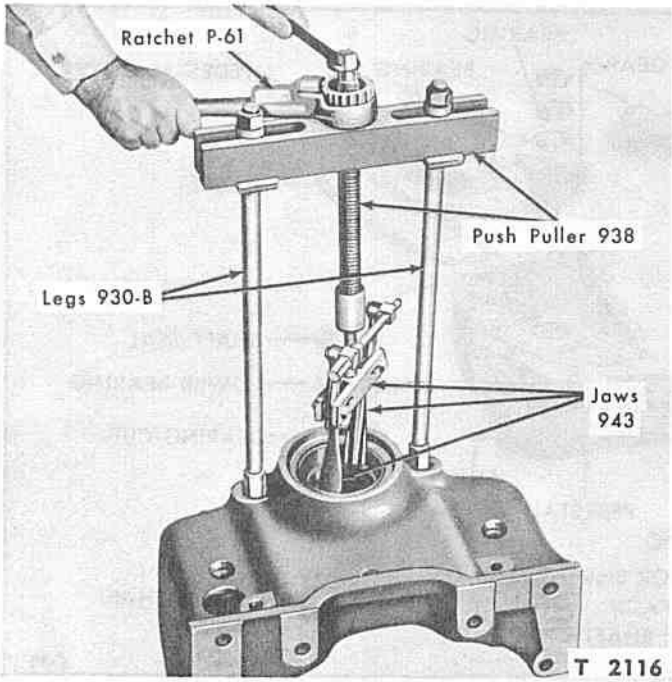


Figure 18—Pulling Pinion Shaft Lower Bearing Cup

the distance from the bottom of the seal to the machined face at the straight edge.

IMPORTANT: ***There is no seat in the bore to retain the oil seal. Exact positioning of the seal must be achieved to prevent oil leakage at the pinion shaft.***

3. Install the sector shaft bushings (inner bushing first) in the bore, using Tool NCB-3179.

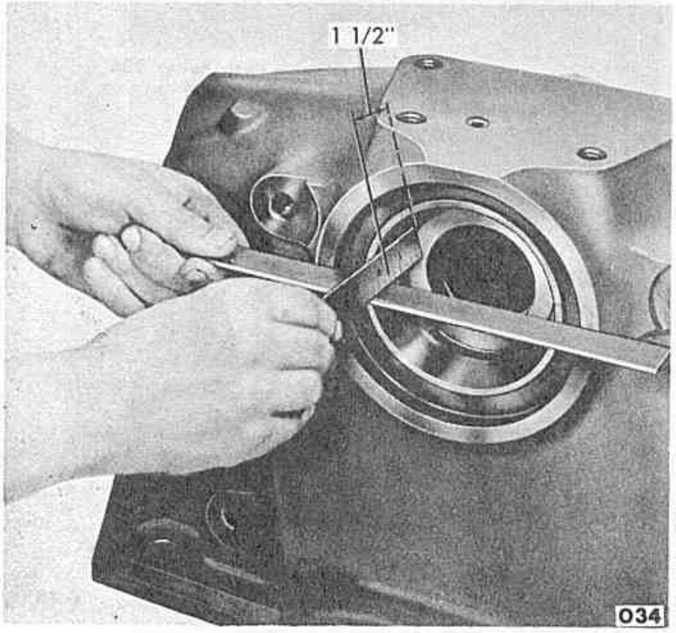


Figure 19—Positioning Oil Seal

4. Insert the sector shaft, threaded end first, into the top of the pedestal housing and through the sector shaft bore.
5. Place the pinion gear over the pinion shaft bore inside the pedestal housing. Rotate the sector shaft at the threaded end, to engage the pinion gear. Make certain that both gears are meshed at the center of travel. When properly engaged, the pinion gear leg should contact either stop in the pedestal housing when rotating the sector shaft.

IMPORTANT: ***Correct gear meshing is required to assure equal turning radius of the pinion shaft.***

6. Pack the large tapered bearing with M-4664 grease and install it on the pinion shaft with Puller 951. Insert the pinion shaft in bore from the bottom of the pedestal housing and push it through the seal and pinion gear, making sure that the master splines on the pinion shaft and pinion gear are properly aligned for spline engagement.

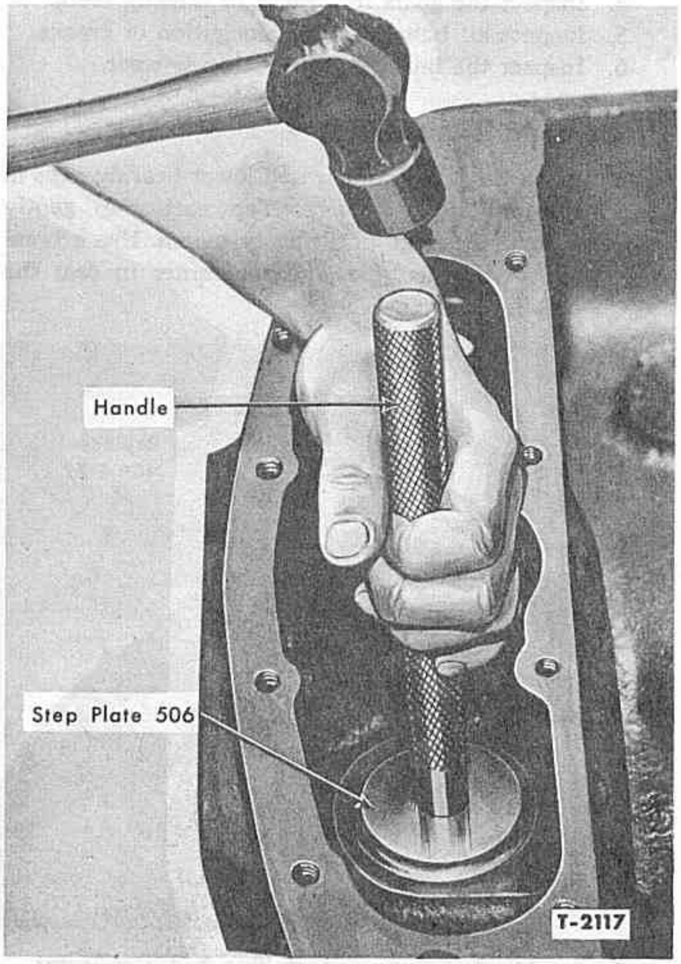


Figure 20—Installing Spindle Upper Oil Seal

7. Pack the upper tapered bearing with M-4664 grease and place it on the pinion shaft and slide it into the bearing cup.
8. Secure the pinion shaft in the pedestal with the castellated nut. Tighten the nut sufficiently to eliminate end play in the shaft, but make sure the shaft turns freely. Install the cotter pin in the nut.

Tractor Serial No. 18122 And Up:

a. Place the shim pack on the sector shaft.

b. Position the cap on the sector shaft.

c. Apply M-4684-G grease in the cavity of the seal lips.

d. Install the seal so the seal flange contacts the cap.

e. Align the seal, shim, and cap bolt holes and secure with the four bolts and lock washers. Tighten to 35-40 ft. lbs.

Tractors Prior To Serial No. 18122:

a. Place the shim pack on the sector shaft.

b. Press a new oil seal into the cap and align the bolt holes in the shim pack and cap.

c. Install the four bolts and lock washers and tighten to 35-40 ft. lbs., securing the cap and shim pack.

NOTE: ***Backlash between the sector gear and the pinion shaft should be from 0.0005-0.0035 inch when the tractor wheels are in a straight ahead driving position. Remove or add shims as necessary to obtain the proper adjustment.***

E. Pedestal Installation

1. Attach the pedestal to the tractor side rails with six nuts, bolts, and lock washers, and tighten to 150-180 ft. lbs.
2. Install the steering arm (in a vertical position for straight ahead driving) on the sector shaft and secure with a nut and lock washer. Tighten the nut to 160-180 ft. lbs. On tractors equipped with power steering, attach the power cylinder.
3. Install the drain plug in the pedestal housing.
4. Fill the pedestal oil reservoir with two quarts of oil, specification EP Lub. SAE 80 winter and summer.
5. Place a new gasket over the pedestal reservoir and install the cover with eight bolts and tighten them to 25-30 ft. lbs. Make sure that the oil level dipstick gasket is in place and that the bolt is tight.
6. Install the front axle as outlined in Row Crop Front Axles Page 347.
7. Install the radiator as instructed on Page 152.

EARLY MODEL PEDESTAL

Due to the manner in which this pedestal is constructed, it is recommended that the unit be disassembled before removing it from the tractor. (The pedestal and wheels can be removed as an assembly for engine repair.)

A. Pedestal Disassembly

Figure 21 is an exploded view of this pedestal assembly.

1. Remove the tractor grille.
2. Remove the eight screws and lift the cover off the pedestal oil reservoir.
3. Place a container under the pedestal. Remove the drain plug on the pedestal front face and allow the oil to drain.
4. Support the front end of the tractor with a hoist or jack.
5. Remove the front wheels from the tractor.

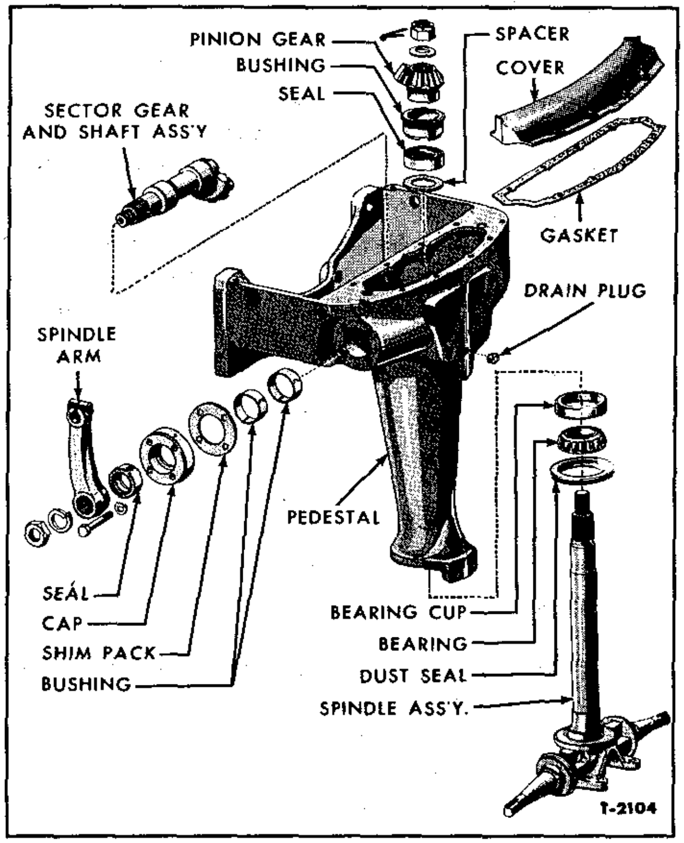


Figure 21—Early Pedestal—Exploded View

6. Remove the nut and lock washer and pull the spindle arm off the sector shaft.
7. Remove the four cap screws and lock washers and remove the cap assembly and shim pack.
8. Remove the cotter pin, nut, and washer from the spindle. Carefully drive the spindle down out of the pedestal housing with a soft mallet. If it is necessary to drive hard, install a nut loosely on the spindle and drive against the nut.

   IMPORTANT: ***Do not allow the spindle to drop on the floor as it comes out of the housing.***

9. Remove the tapered bearing from the spindle using Puller 951.
10. Rotate the pinon gear until it is disengaged and lift it out of the pedestal.
11. Lift the sector shaft, gear end first, out of the pedestal.
12. The sector shaft bushings can be removed and installed with the pedestal either on or off the tractor. Use Tool NCB-3179 to drive the bushings out or to install the bushings, Figure 16.

B. Pedestal Removal

This procedure is based on prior disassembly of the pedestal.

1. Remove the radiator, as outlined on Page 152.
2. Remove the four pedestal-to-side rail, and two pedestal-to-engine front support nuts and bolts. With the pedestal firmly supported, pull it away from the tractor.

   NOTE: ***It may be necessary to loosen the generator adjusting bracket to obtain access to the lower pedestal-to-side rail retaining nuts.***

C. Pedestal Repair

1. Clean all metal parts with solvent.
2. Check the pedestal mounting faces for nicks and burrs.
3. Check the bolt holes for cracks and elongation.
4. Inspect the pedestal for cracks.
5. Inspect the spindle, pinion gear, and sector gear and shaft for wear, distortion, or chipped teeth.
6. Check the bushings for wear. If the bushings are worn, replace as follows:
   a. Use a suitable driver and drive the spindle bushing, spacer, and oil seal out (toward the top) of the pedestal.
   b. Place a spacer in the shoulder in the pedestal, and drive a new oil seal into place, using Tool N-506, as shown in Figure 20. Be sure the oil seal is bottomed against the spacer.
   c. Press a new bushing into place. Be sure the bushing is seated firmly in the recess at the top of the spindle housing.
7. Pull the seal and bearing cup out of the bottom of the pedestal.
8. Using a suitable adapter or hammer and block of wood, install the bearing cup. Insert a new oil seal.

D. Pedestal Installation

1. Position the pedestal to the tractor and install the mounting bolts.
2. Tighten the generator adjusting bracket if it was loosened.
3. Install the radiator.

E. Pedestal Assembly

1. Install the sector shaft, threaded end first.
2. Insert the pinion gear and rotate the sector shaft and gear until the sector gear and pinion gear engage. Be sure the gears are meshed at the center of gear travel.
3. Place the tapered bearing on the spindle shaft using Bearing Puller 951.
4. Insert the spindle into the housing and push it up into the pinion gear. Be sure the master splines on the pinion and spindle are aligned when the splines are engaged.
5. Place the washer, flat side down, on the spindle and install the nut. Tighten the nut until end play is eliminated, then check to be sure the spindle turns freely.
6. Install the shim pack and cap over the end of the sector shaft. With the cap retaining bolts tightened to 25-30 ft. lbs., the backlash between the sector gear and pinion gear should be 0.0005-0.0035 inch, when wheels are in straight ahead position. Add or remove shims to obtain the proper backlash.
7. Position the spindle arm on the sector shaft and install the lock washer and nut.
8. Install the front wheels.
9. Fill the pedestal oil reservoir with the proper lubricant.
10. Use a new gasket and install the reservoir cover.
11. Install the tractor grille.

4. ROW CROP WIDE ADJUSTABLE FRONT AXLE

The right and left axle sections and the spindle assemblies used on the wide adjustable front axle are essentially the same as those used on the general purpose front axle, except that the left and right spindles are reversed to align the keyways for straight ahead steering. For removal and disassembly of the axle halves, refer to Page 341. Figure 22 is an exploded view of the entire wide adjustable front axle.

CENTER AXLE AND RADIUS ROD

A. Removal

1. Remove the complete axle assembly from the tractor. Refer to Page 347.
2. Disconnect the axle halves from the center axle by removing the four bolts, flat washers, and nuts.
3. The center axle is attached to the axle support with an axle pin that is locked in position in the flanges of the axle support by a lock pin, Insert A, Figure 23. Remove the nut and flat washer from the lock pin and drive the pin out with a drift.
4. Drive the axle pin from the support flanges.
5. The radius rod is held in position between the rear flanges of the axle support by a pin that is locked in place with a roll pin, Insert B, Figure 23. Drive the roll pin out of the flange with a drift, and drive the radius rod pin out, working from the rear of the support. Remove the radius rod pin thrust washer.
7. Lift the axle support off the radius rod and center axle.
8. Disconnect the radius rod from the center axle by removing two bolts and nuts.

B. Repair

1. *Clean all metal parts in cleaning solvent.*
2. Inspect the center axle and radius rod for distortion or fracture.
3. Inspect the bushings in the center axle and radius rod for damage or excessive wear.

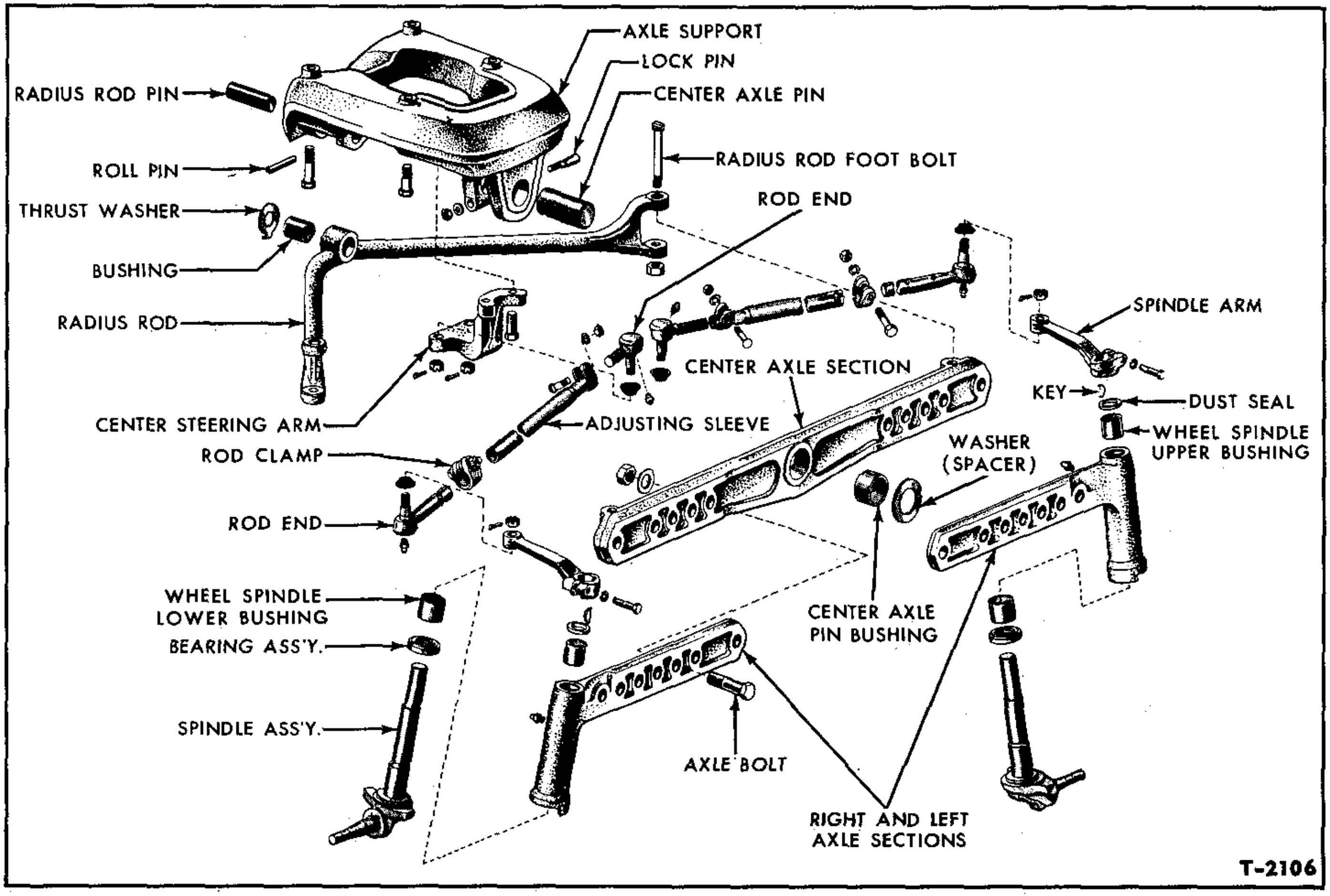


Figure 22—Exploded View—Wide Adjustable Front Axle

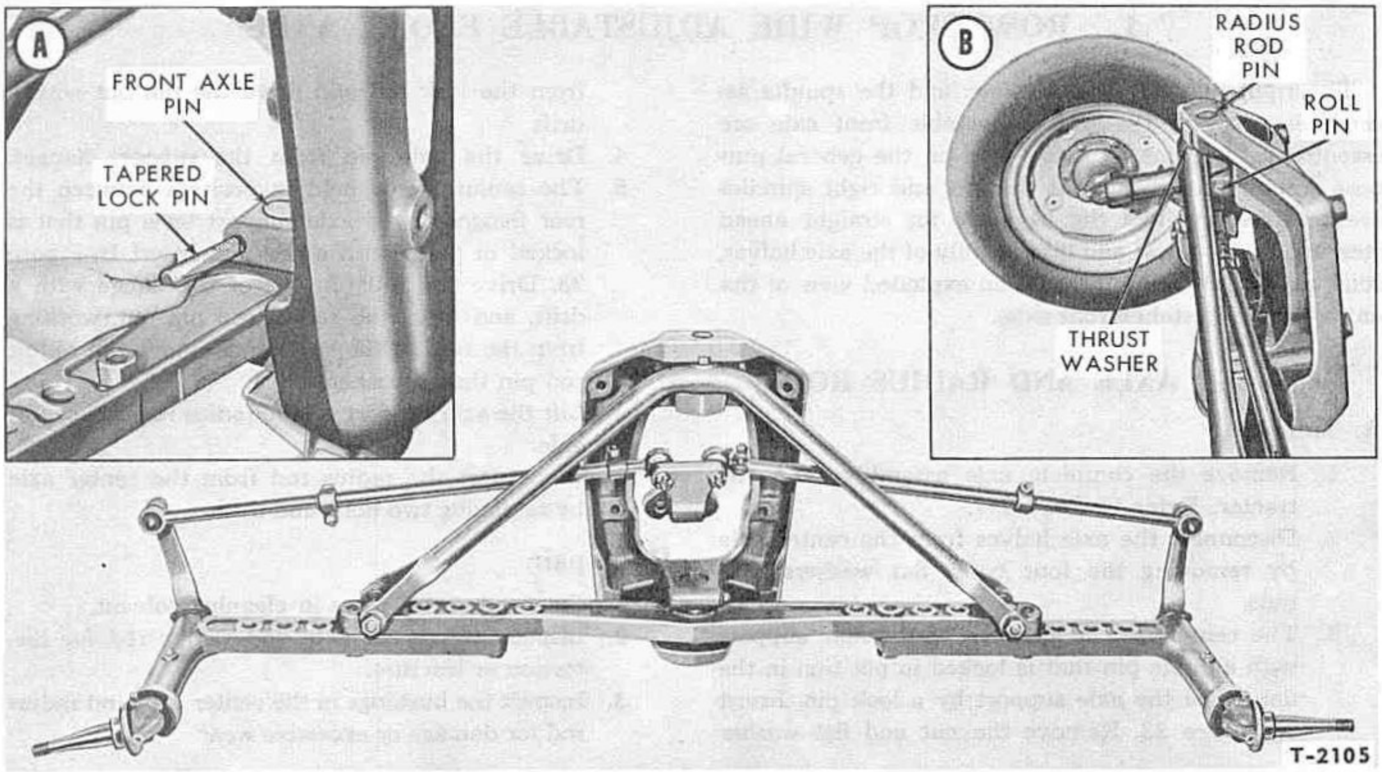


Figure 23—Wide Adjustable Front Axle— Wheels Removed

4. Remove damaged bushings with a suitable puller.
5. Install new bushings with an arbor press.

C. Installation

1. Attach the radius rod to the center axle using two bolts and nuts. Tighten them to 75-135 ft. lbs.
2. Position the center axle on the axle halves using bolts as guides.
3. Position the axle support down over the radius rod and center axle as shown in Figure 23.
4. Align the axle pin holes in the axle support and center axle, and with the required number of washers on the axle pin, drive the pin into the mounting flange.
5. Insert the lock pin through the flange and axle pin, Figure 23. Install the washer and nut and tighten the nut to 50-55 ft. lbs.
6. Insert the radius rod pin through the rear support flange and into the radius rod. Place the thrust washer on the pin so the hooked projection of the washer rests on the rear flange support, Figure 23.
7. Using a narrow drift, align the cross hole in the radius rod pin with the holes in the support flange. Drive the roll pin through the hole in the support flange into the cross hole in the radius rod pin.
8. Install the washers and nuts on the axle-half-to-center axle bolts and tighten them to 220-250 ft. lbs.
9. Install the complete front axle assembly to the pedestal, as outlined on Page 347.

DRAG LINK ASSEMBLY AND TOE-IN ADJUSTMENT

A. Drag Link Assembly Removal

1. Remove the cotter pin and castellated nut from both ends of the spindle connecting rod, Figure 24.
2. Use Puller 1001 and Step Plate 630-1 on the spindle connecting rod ends to remove the assembly from the steering center arm and spindle arm.

   IMPORTANT: ***Do not try to hammer the rod ends since thread damage will result.***
3. To remove the spindle connecting rod end, simply loosen the sleeve clamp and turn the rod end out.

B. Drag Link Assembly Installation

1. Thread the spindle connecting rod ends approximately half way into the sleeve.
2. Attach the drag link assembly to center steering arm and the spindle arm, tighten the nuts to 90-130 ft. lbs. Use new dust caps if necessary.

3. Check the wheel for straight ahead position. Disconnect the spindle connecting rod and screw in or out until straight ahead position is obtained.
4. Adjust toe-in.

C. Toe-In Adjustment

1. With the drag link sleeve clamps loosened and the tractor wheels in a straight ahead position, rotate the drag link sleeves as required to provide a total toe-in of ¼" to ½".
   NOTE: ***Degree of toe-in should be equal for both front wheels.***
2. Toe-in is measured from the outside of the tire ribs, at the hub horizontal centerline, at the front and rear of the tires.
3. Tighten the sleeve clamps to 25-30 ft. lbs.

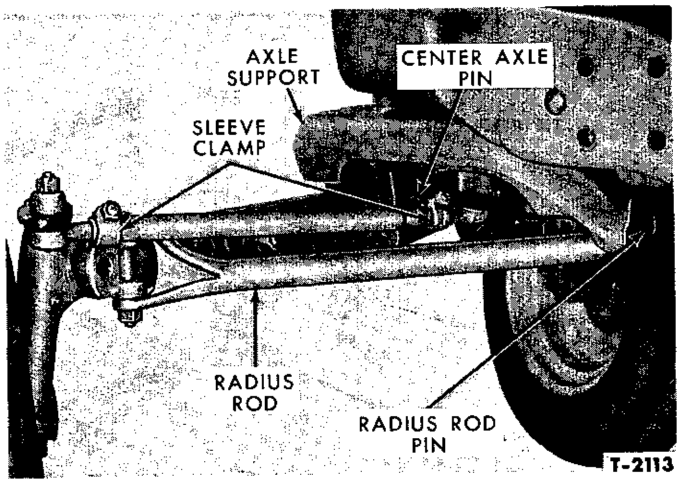


Figure 24—Removing Drag Link

5. INDUSTRIAL FRONT AXLE

The industrial front axle is a non-adjustable type and is held in the yoke of the front support member by a solid axle pin. The pin is keyed to the support to prevent axle rotation. The wheel spindles are secured to the axle by vertical spindle pins locked in place with spindle locking pins, washers, and nuts. A power cylinder is secured to the left side of the axle and to the right steering arm. Figure 25 is an exploded view of the industrial axle.

TIE ROD ASSEMBLY AND STEERING ARMS

The tie rod assembly controls wheel movement and provides toe-in adjustment of the front wheels. The tie rod is attached to the steering arms with tie rod ends. The steering arms are attached to the wheel spindle assemblies.

A. Tie Rod Removal

1. Remove the cotter pin and castellated nut from each tie rod end, Figure 26.
2. Using Puller 1001 and Step Plate 630-1, remove the tie rod ends from the steering arms and withdraw the tie rod assembly.

   NOTE: ***Do not hammer on the tie rod ends to free them from the steering arms as thread damage will result.***
3. To remove a tie rod end, loosen the tie rod clamp and turn the rod end out.

B. Tie Rod Installation

1. Thread the tie rod end approximately half way into the tie rod and install the dust cap.
2. Insert the tie rod end into the steering arm.
3. Secure the right tie rod end with a castellated nut and cotter pin.
4. Position the right front wheel straight ahead, using engine for power if necessary.
5. Check the left front wheel. If the left front wheel is not in a straight ahead position, remove the left tie rod end from the steering arm and rotate the rod end in or out of the tube to obtain straight ahead position.
6. After straight ahead position has been obtained, secure the left tie rod end with the castellated nut and cotter pin. Do not tighten the tie rod clamp.
7. Adjust toe-in.

C. Toe-In Adjustment

1. With the tie-rod clamps loosened and the front wheels positioned straight ahead, rotate the tie rod as required to obtain toe-in adjustment of ¼" to ½".
2. Toe-in is measured from the outside of the tire ribs, at the hub horizontal centerline, at the front and rear of the tires.
3. Tighten the tie rod clamp nuts to 50-60 ft. lbs.

STEERING ARM

A. Removal

Either the left or right steering arm, which is shown in Figure 27, may be removed without disturbing the wheel hub or wheel assembly.

1. Remove the tie rod end from the steering arm.

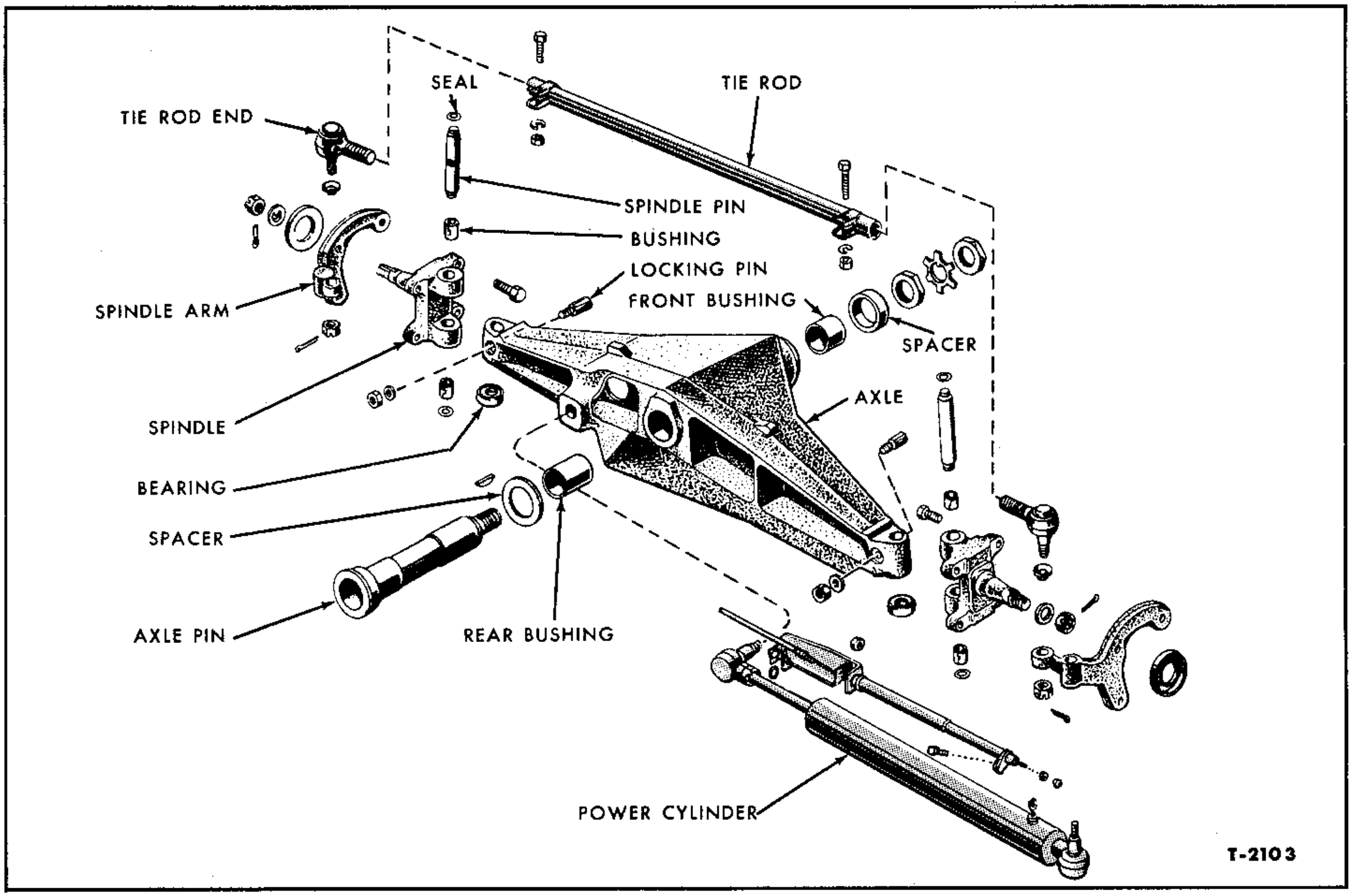


Figure 25—Industrial Front Axle

NOTE: ***When removing the right steering arm, disconnect the power cylinder anchor stud from the arm by removing the cotter pin and castellated nut. Lower the cylinder to the floor.***

2. Cut the lock wire and remove the three steering arm-to-spindle bolts.
3. Remove the steering arm.

B. Installation

1. Position the steering arm to the spindle and install the three bolts.
2. Tighten the bolts to 120-160 ft. lbs. and install lock wire.
3. Install the rod end to the steering arm. If the power cylinder was disconnected, install it.

FRONT AXLE ASSEMBLY

A. Removal

The front axle assembly may be removed from the tractor with or without the wheels installed.

1. Disconnect the right tie rod end
2. Disconnect the power cylinder assembly including the anchor stud, hose connections, and cable control. See Page 299.

   NOTE: ***Steps 1 and 2 are necessary to obtain axle pin clearance.***

3. Remove the four Phillips head screws and remove the tractor grille.
4. Pass a chain loop through the center hole of the axle support member and secure it with a bolt as shown in Figure 28. Attach the chain to an overhead hoist or lift and take up the slack.
5. Position a floor jack under the center of the front axle. Raise the jack until it touches the axle.
6. Straighten the tabs on the keyed washer located behind the jam nut on the front of the axle pin, Figure 28.
7. Remove the jam nut, keyed washer, and lock nut from the axle pin.
8. While driving the axle pin rearward, adjust the tractor and axle weight with the hoist and floor jack to remove tension from the axle pin.
9. When the axle pin has cleared the front yoke of

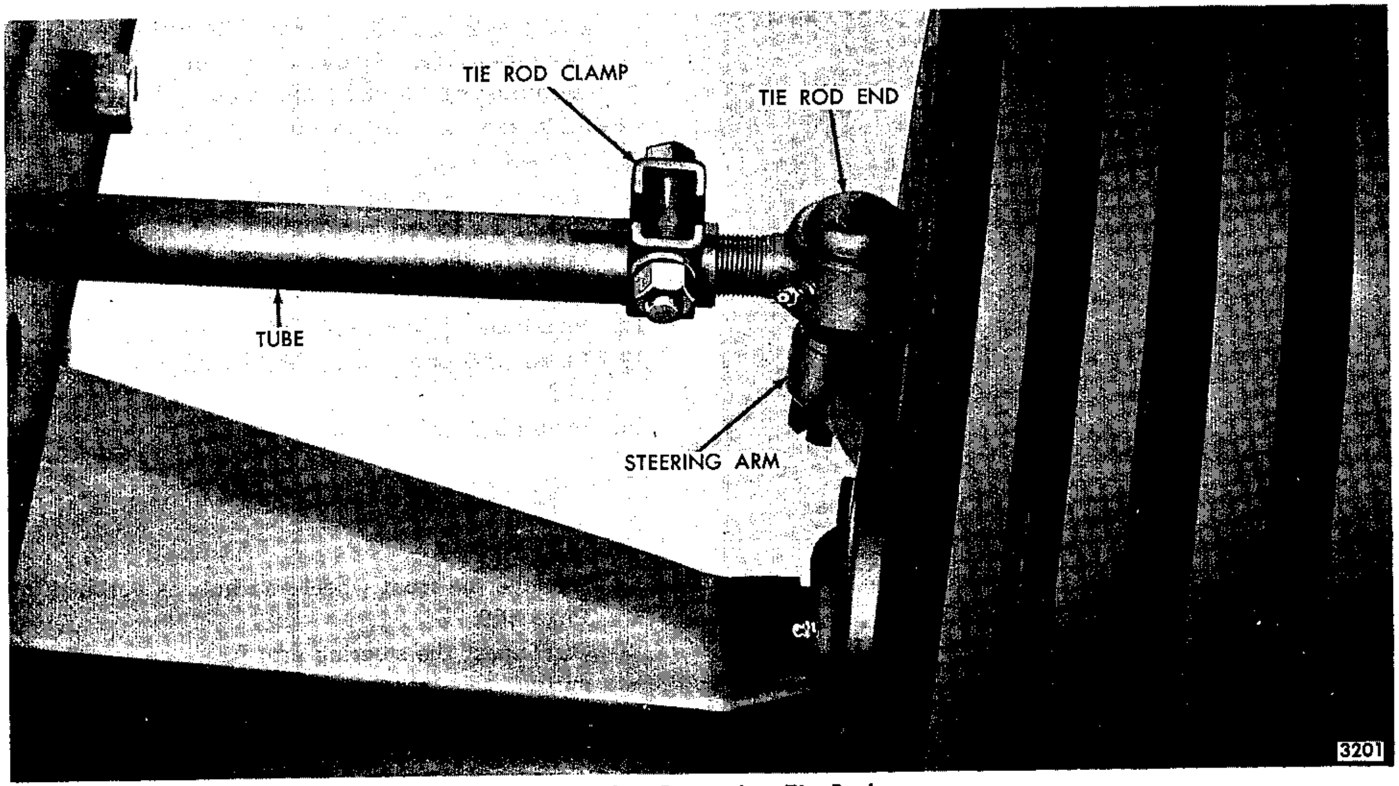


Figure 26—Removing Tie Rod

the support, remove the axle pin front thrust bearing, Figure 29.

NOTE: ***The left front wheel has been removed in Figure 29 for illustration purposes only.***

10. Tilt the axle assembly rearward by positioning the jack at the front end of the axle. This will provide axle pin to oil pan clearance.
11. Remove the axle pin, rear thrust bearing, and Woodruff key assembled.
12. Reposition the jack under the center of the axle.

CAUTION: ***If the axle is being removed without the wheels on the spindle, use an additional jack to support the axle rather than repositioning the jack.***

13. Raise the front of the tractor to clear the axle as shown in Figure 30, and pull the axle assembly forward with the floor jack.

B. Repair

Axle bushing wear can be detected before the axle is removed from the tractor. It is good practice to check the axle for excessive play when servicing the front end. There are two bushings in the axle pin bore on the front axle; the front bushing, shown in Figure 30, and the rear bushing, located at the rear of the bore. Both bushings have the same diameter, however, the front bushing is longer. If the bushings are loose, but do not appear to be defective, the looseness is caused by a slight eccentricity of the bushing bores. This problem can be overcome by welding a spot or bead on the inner end of the bushing bore in the axle. Then notch one end of the bushing to correspond with the bead and insert the bushing so the weld bead is in the notched area.

1. Inspect the axle for cracks or other defects.
2. Inspect the axle pin bearing surfaces for scoring.
3. Inspect the thrust bearing for cracks or burrs.
4. Inspect the bolt holes for elongation.
5. Inspect the front and rear bushing. If damaged, remove them from the axle pin bore using a cape chisel.
6. Install a new bushing flush with the bore end using Step Plate 630-12.

C. Installation

1. With the front end of the tractor raised sufficiently for axle and front support clearance, position the axle assembly between the yokes using a floor jack to support the axle.
2. Lower the front end of the tractor so that the yokes on the front support member straddle the axle and the axle pin bore and the holes in the yokes are aligned.

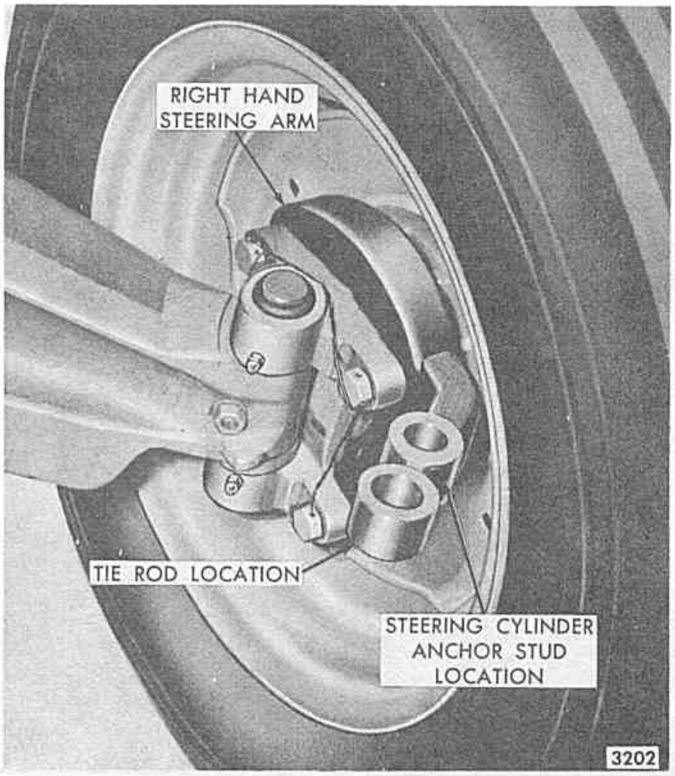


Figure 27—Removing Spindle Arm

3. Slip the rear thrust bearing on the axle pin, Figure 29, and insert the Woodruff key, Figure 30, in the recess at the rear of the keyway.
4. Insert the axle pin (keyway up) through the rear yoke of the support and tilt the axle assembly at the rear end with the floor jack. Raise the tractor as necessary to start the pin into the axle pin bore.
5. Reposition the axle assembly with the floor jack and lower the tractor until the axle pin bore aligns with the hole in the front of the support yoke.
6. Position the rear thrust bearing in the rear yoke of the support member as shown in Figure 31. This centers the axle pin and makes further installation easier.
7. Push the axle pin through the axle bore until the threaded end just protrudes from the axle bore. Position the front thrust bearing on the pin.
8. Continue to slide the pin forward until the large O.D. of the pin protrudes from the axle pin bore. Position the thrust bearing on the pin as shown in the insert to Figure 31.

   NOTE: ***During the procedure, the keyway in the axle pin must line up with the keyway in the front yoke so the Woodruff key can enter the yoke.***

   If the axle pin will not rotate by hand for alignment purposes, remove the strain from the pin by adjusting the hoist and floor jack.
9. Slide the axle pin in until it seats on the rear thrust bearing.
10. Install the lock nut and tighten it to 150 ft. lbs.
11. Install the keyed lock washer and bend the three tabs over the flats on the lock nut and install the jam nut.
12. Install the right tie rod end.
13. Install the power cylinder, as outlined on Page 299.
14. Install the tractor grille.

WHEEL SPINDLE ASSEMBLY

A. Removal

1. Remove the front wheel and hub, as outlined on Page 369.
2. Disconnect the steering arm from the spindle by cutting the lock wire and removing the three bolts.
3. Position the steering arm with the power cylinder and/or tie rod aside, as shown in Figure 32.
4. Remove the nut and lock washer from the tapered locking pin.
5. Drive the locking pin out of the spindle pin from the rear, Figure 32.

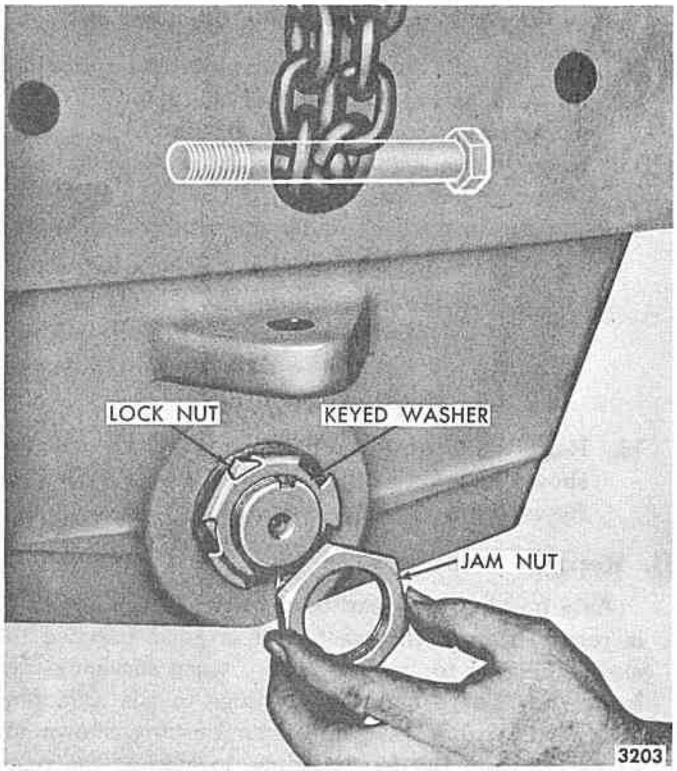


Figure 28—Removing Axle Pin Jam Nut and Lock Nut

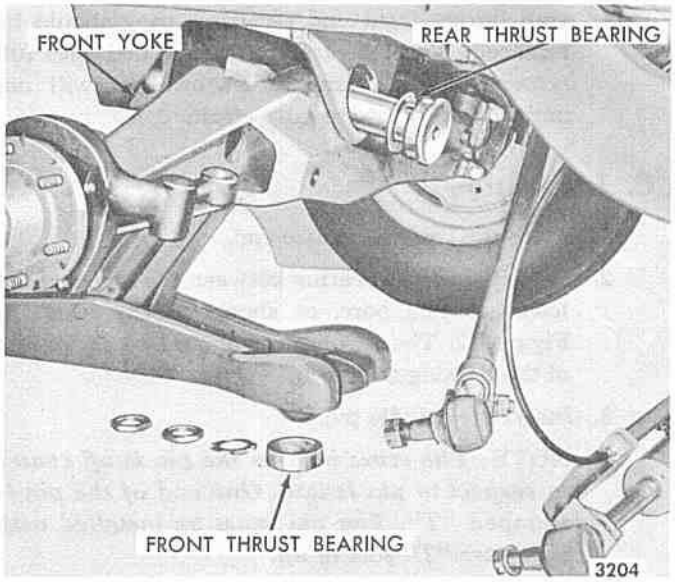


Figure 29—Removing Axle Pin

6. Drive the spindle pin upward slightly and remove the spindle pin top seal.
7. Drive the spindle pin downward, out of the spindle assembly. Lift the spindle assembly off the axle.
8. Lift the thrust bearing off the spindle.

B. Repair

1. Inspect the bushings for cracks, burrs, or scoring. If the spindle pin fit was sloppy or any side play was evidenced before disassembly, replace the bushings. Both bushings can be removed and installed with Bushing Driver 809, and Handle 814, as shown in Figure 33. The triangular hole in the bushing must be aligned with the hole in the spindle.

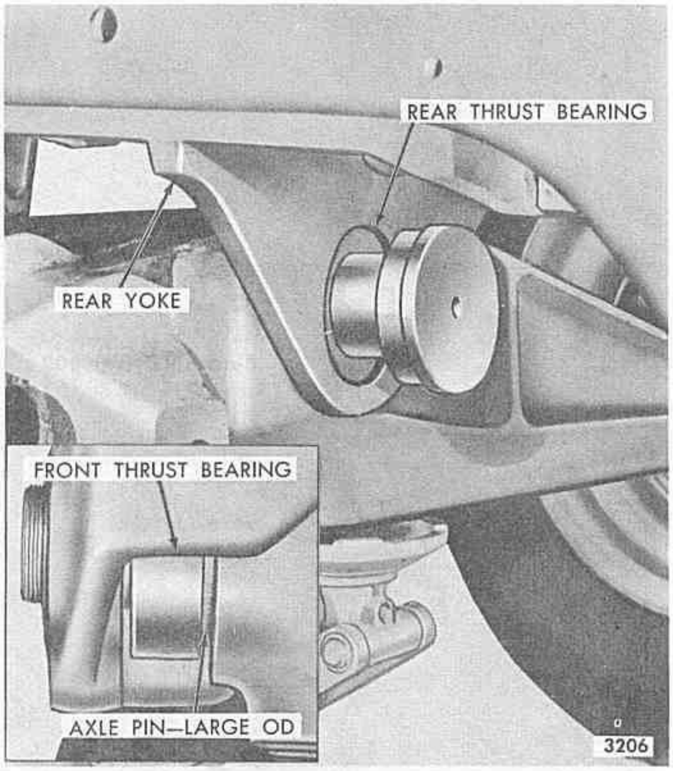


Figure 31—Axle Installation and Thrust Bearing Placement

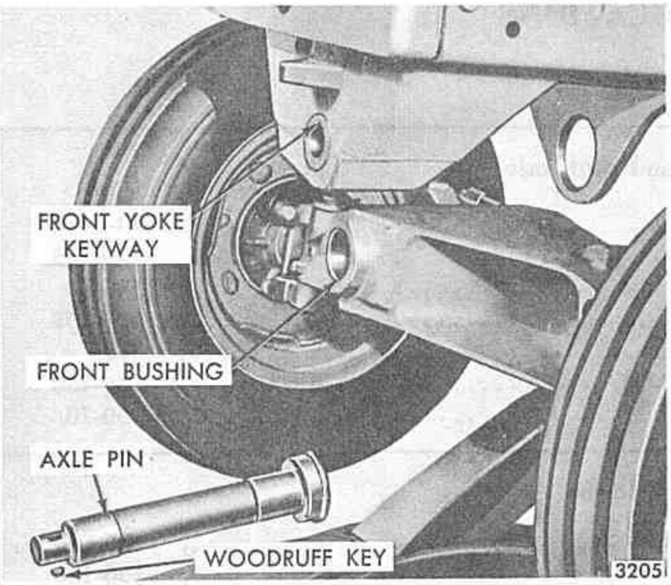


Figure 30—Removing Front Axle

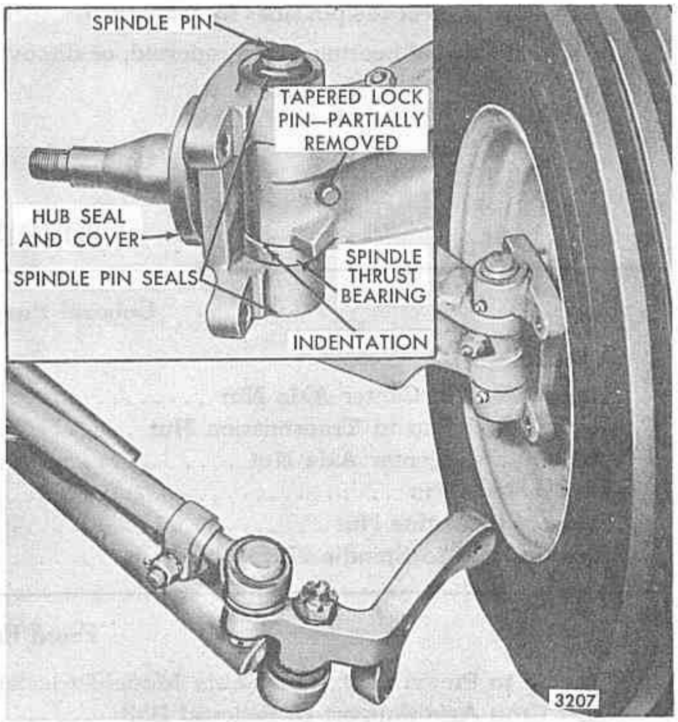


Figure 32—Spindle Removal

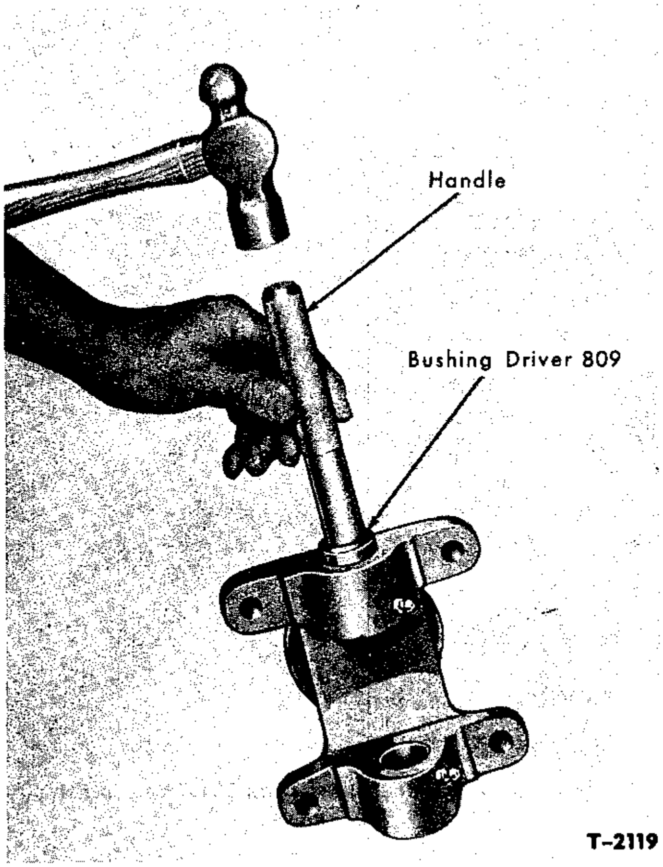


Figure 33—Spindle Bushing Replacement

2. Inspect the spindle for cracks, burrs, or other defects. Inspect the pin sides for wear.
3. If noisy thrust bearings were reported, or discovered during front end servicing, they should be replaced. Since the tractor is equipped with full power steering, worn thrust bearings will not impart a drag to steering effort.

C. Installation

1. Place the spindle on axle end.
2. Place the thrust bearing between the axle and the lower spindle bore, as shown in the insert in Figure 32. The indentation should be at the top of the bearing as shown.
3. Insert the spindle pin.

   NOTE: ***The cross bore in the pin is off center in respect to pin length. One end of the pin is stamped "T". The pin must be installed with the letter "T" facing up.***
4. Rotate the spindle pin until the cross bore of the pin aligns with the cross bore of the axle.
5. Drive the tapered pin into the axle cross bore and through the spindle pin.
6. Install the lock washer and nut on the tapered pin and tighten to draw the pin fully into position.
7. Install the top and bottom mud seals on the spindle pin.
8. Install the steering arm with the power cylinder and/or tie rod, tighten to 120-160 ft. lbs.
9. Install the front wheel and hub as outlined on Page 369.

6. SPECIFICATIONS

TORQUE CHART

General Purpose Front Axle	
Identification	**Ft.-Lbs.**
Radius Rod to Center Axle Nut	75-135
Radius Rod Cap to Transmission Nut	45-50
Axle Half to Center Axle Nut	135-150
Center Axle Pin	200
Support to Engine Nut	135-150
Spindle Arm to Spindle Nut	60-70
Front End Options	
Spindle to Pinion Shaft Bolt (Late Model Pedestal Mounting Bolts)	135-150
Row Crop Axle Support to Pedestal Bolt	150-180
Row Crop Steering Arm to Pinion Shaft Bolt	150-180

TORQUE CHART CONT'D.

Row Crop Pedestal

Sector Shaft Cap to Pedestal Bolt	35-40
Pedestal to Side Rail Nut	150-180
Steering Arm to Sector Shaft Nut	160-180
Pedestal Cover to Pedestal Bolt	25-30

Row Crop Wide Adjustable

Radius Rod to Center Axle Nut	75-135
Axle Pin Lock Nut	50-55
Axle Half to Center Axle Nut	220-250
Tie Rod to Spindle Arm Nut	90-130
Tie Rod Sleeve Clamp Nut	35-30

Industrial

Tie Rod to End Assembly Clamp Bolt	50-60
Tie Rod to Steering Arm Nut	150-170
Tie Rod Clamp Nut	50-60
Steering Arm to Spindle Bolt	120-160
Axle Pin Lock Nut	150
Spindle Pin Lock Nut	25-30

7. TROUBLE SHOOTING

There are no definite procedures for trouble shooting front axles. A visual inspection should be made to check for bent or sprung members, and for cracks in exterior housings such as center axle, pedestal, and axle halves. Hard steering can be caused by bent or distorted tie rods, steering arms, or spindle arms. Steering drag is usually caused by damaged spindle bearings. All pivot points of the front axle should be checked for end or side play. On "Row Crop" model tractors, check for evidence of lubricant leakage around pedestal assembly. Check grease fittings for damage and replace as necessary. Inspect all exposed oil or dust seals for damage or weathering and replace as necessary. Many malfunctions may readily be diagnosed by the description of the trouble as reported by the owner.

8. SPECIAL TOOLS

The following special tools will assist in the disassembly and assembly of front axles:

Tool Number	Description
FT-48	Tool Set
NCB-3179	Driver
N-506	Driver
T-818	Driver Set

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS AND TIRES

Chapter

III

Brakes

Section		Page
1	Brake Adjustment	362
2	Pedals, Shaft and Brake Rods	363
3	Brake Camshaft	366
4	Brake Overhaul	366

1. BRAKE ADJUSTMENT

Series 600 through 1801 Ford Tractors are equipped with mechanical, two shoe, internal expanding type brakes on the rear wheels. The brake assembly is shown in Figure 1. The brakes are controlled through pedals located on the right side of the tractor, and the necessary linkage to connect the pedals with the brake assembly at each wheel. The tractor brakes are constructed with bonded linings. Therefore, when linings become worn, the complete shoe assembly is replaced.

Each brake is equipped with a locking pawl so that either one or both of the rear wheels can be locked with the brake in the applied position. It is good safety practice to apply the brakes and lock them whenever you are working around a tractor with the engine running.

Brakes are subject to wear through the course of normal operation. For this reason, particular attention should be given to proper brake adjustment. Brake adjustments are classified in two categories as follows:

A minor brake adjustment re-establishes the clearance between brake lining and brake drum and compensates for normal lining wear, without any disassembly consideration.

A major brake adjustment includes removal of the rear wheels and brake drums in addition to a close inspection of all parts of the brake system to determine whether or not extensive repairs are necessary.

A. Minor Brake Adjustment

1. Raise the tractor so that both rear wheels clear the floor.
2. Remove the brake adjusting hole covers from the brake backing plates.
3. With the brake pedals in the released position, turn the brake adjusting screw clockwise as shown in Figure 2, until there is a noticeable drag on the brake drum as the wheel is turned.
4. Turn the brake adjusting screw counterclockwise until only a slight drag is noticed as the wheel is turned. Install the brake adjusting hole cover. Adjust the other brake in the same manner.

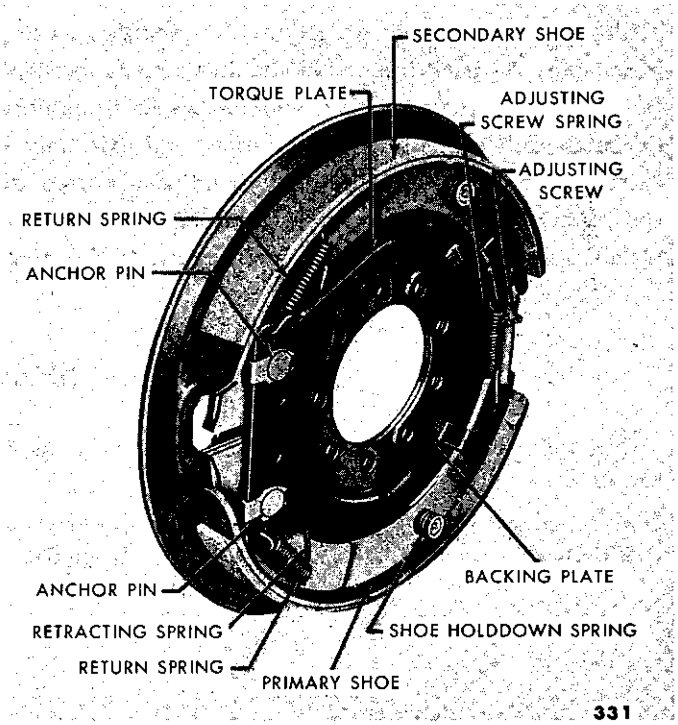


Figure 1—Brake Assembly

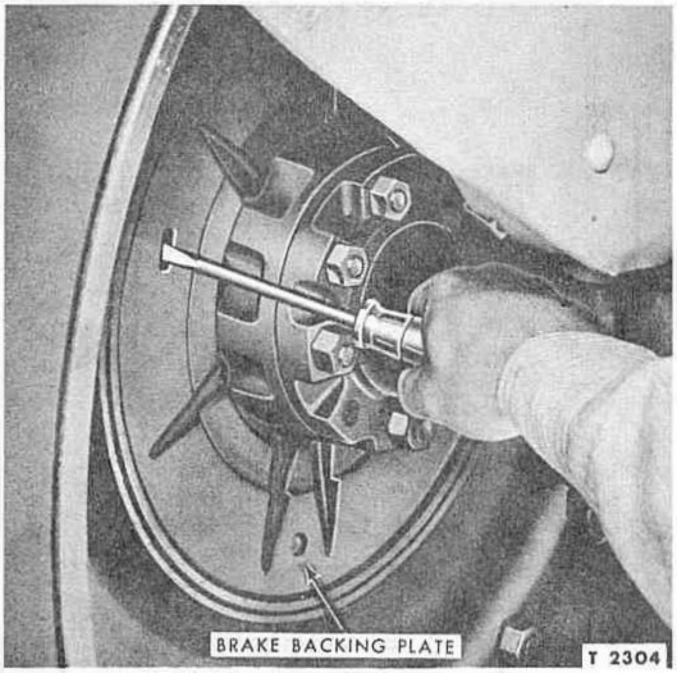


Figure 2—Adjusting Brake Shoes

5. Adjust the length of the brake rod at the clevis to bring both brake pedals level, Figure 3. Install the clevis pin and cotter pin and tighten the clevis lock nut.

Test drive the tractor to check brake operation. Inspect for overheated drums and, if necessary, readjust the brakes.

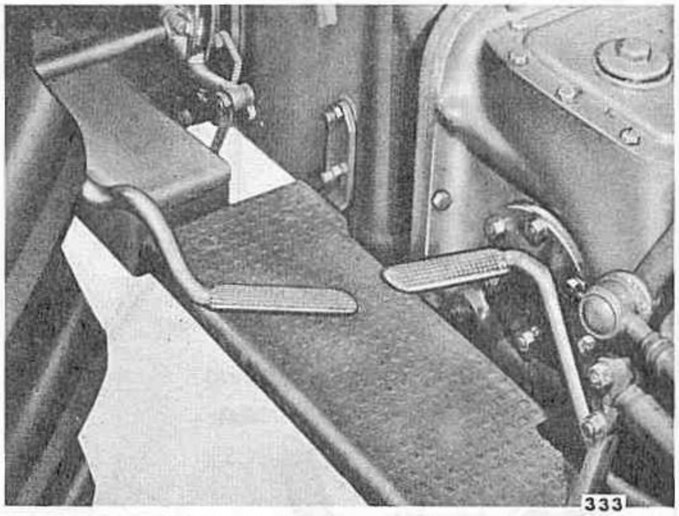


Figure 3—Brake Pedals Properly Adjusted

B. Major Brake Adjustment

1. Raise the rear of the tractor and place jack stands under each side of the rear axle housing.
2. Remove both rear wheels.

   NOTE: ***If the tractor is equipped with wheel weights, it will be necessary to remove the weights before removing the wheels. Refer to Page 376 for information on weight removal.***

3. Remove the two screws or three spring nuts that attach each brake drum to the axle shaft and remove the drum.
4. Clean the drums and brake assemblies and inspect for wear. Check the condition of the retracting springs and the return springs. Weak springs should be replaced. Worn brake linings should be replaced. Scored brake drums should be turned in a brake drum lathe. Depress each brake pedal to make sure the linkage operates freely. All worn linkage should be replaced.
5. Position the drums on the axle shafts and install the attaching screws or spring nuts.
6. Raise the tractor, remove the jack stands, then lower the tractor as necessary to mount both wheels. Install the wheel lug nuts (except tractors with wheel weights) and tighten them securely.
7. Adjust the brakes as detailed in Paragraph A.

2. PEDALS, SHAFT AND BRAKE RODS

The brake pedals are located on the right side of the tractor on all models, and the shaft and linkage arrangement is similar, whether the tractor is equipped with a four speed, five speed, or Select-O-Speed transmission. Prior to 1958, the clutch shaft and linkage arrangement on a four speed transmission differs from that of a five speed transmission. Starting with 1958 models, the brake linkage is identical on all models. The brake pedal arrangement shown in Figure 3 was used prior to 1958.

The clutch and brake pedals, plus the necessary linkage, are shown in Figure 4.

A. Removal

1. Remove the left brake pedal attaching bolt, then remove the pedal from the shaft.
2. Disconnect the brake rod clevis from the lever on the left side of the cross shaft.

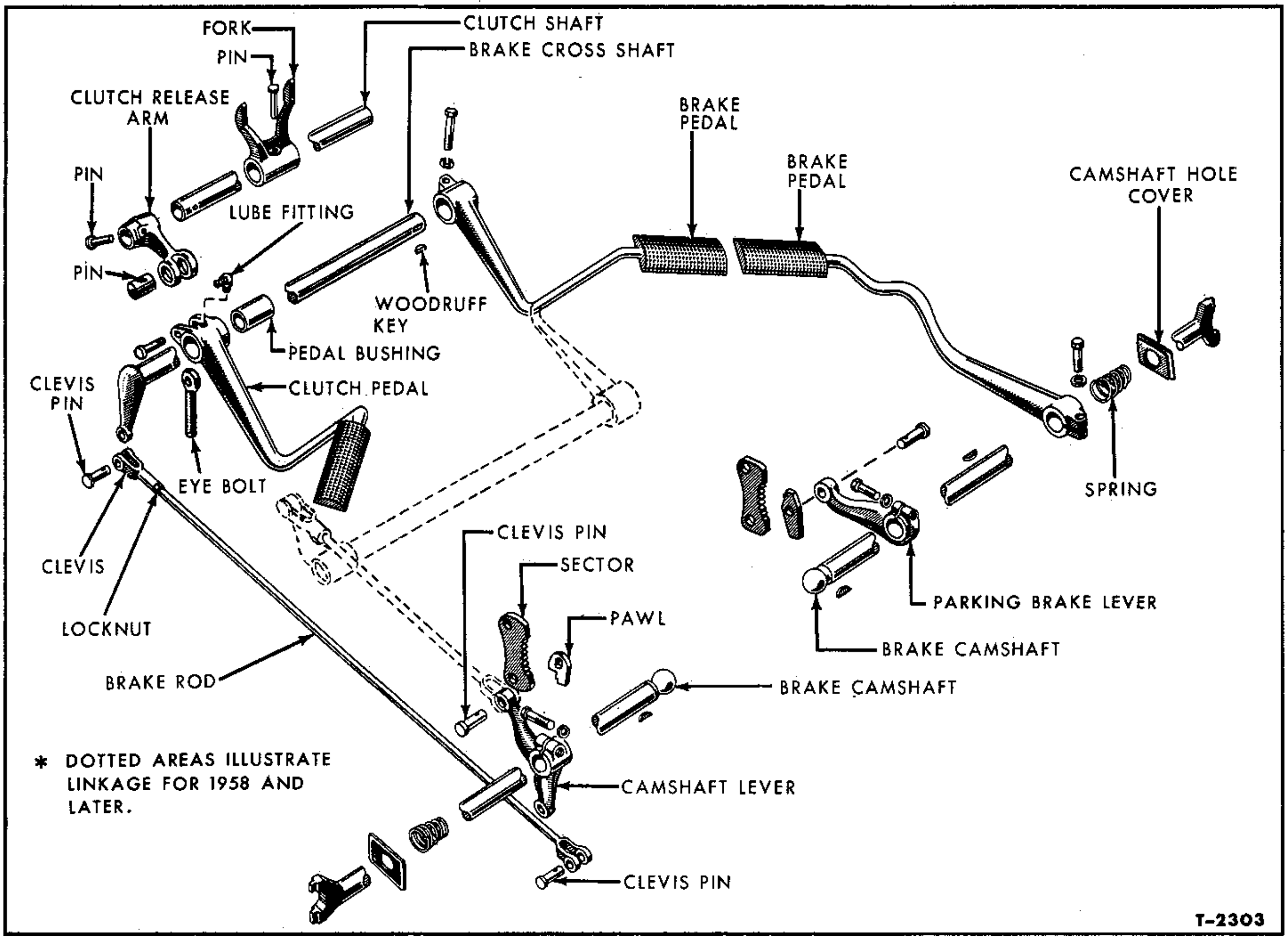


Figure 4—Clutch and Brake Pedals and Linkage—Typical

3. Slide the cross shaft out from the left side of the transmission.

   NOTE: ***If the tractor is equipped with the horizontal exhaust system, it will be necessary to disconnect the rear clamp from the axle housing and lower the outlet pipe to provide clearance. On tractors equipped with four speed transmissions prior to 1958, the cross shaft slides out of the clutch pedal.***

4. Remove the bushings from the transmission case or center housing with Clutch Pilot Bearing Remover 7600-E.

   NOTE: ***Remove the bushings only if they are worn.***

B. Installation

1. Install the bushings in the transmission case or center housing with Bushing Driver 809 from Bushing Driver Set 818.

2. Coat the cross shaft with Lubriplate and slide it through the left side of the transmission case or center housing.

   NOTE: ***On models built prior to 1958 and equipped with a four speed transmission, the cross shaft is slipped through the clutch pedal before entering the transmission case.***

3. Connect the outlet pipe rear hanger to the axle housing (horizontal exhaust system only).

4. Connect the brake rod to the cross shaft lever with a clevis pin and cotter pin.

5. Secure the brake pedal to the cross shaft with a nut and bolt.

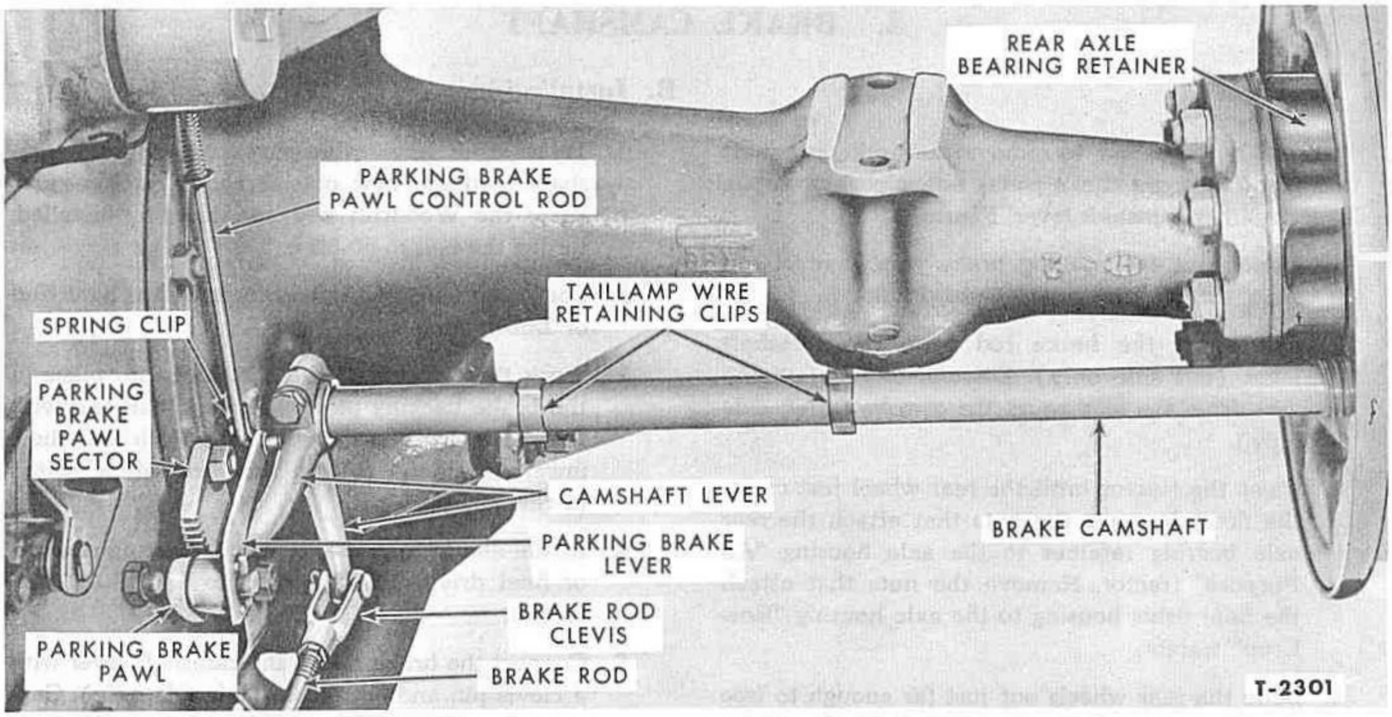

REAR AXLE BEARING RETAINER
PARKING BRAKE PAWL CONTROL ROD
TAILLAMP WIRE RETAINING CLIPS
SPRING CLIP
PARKING BRAKE PAWL SECTOR
CAMSHAFT LEVER
PARKING BRAKE LEVER
BRAKE CAMSHAFT
BRAKE ROD CLEVIS
PARKING BRAKE PAWL
BRAKE ROD
T-2301

Figure 5—Parking Brake Linkage Installed

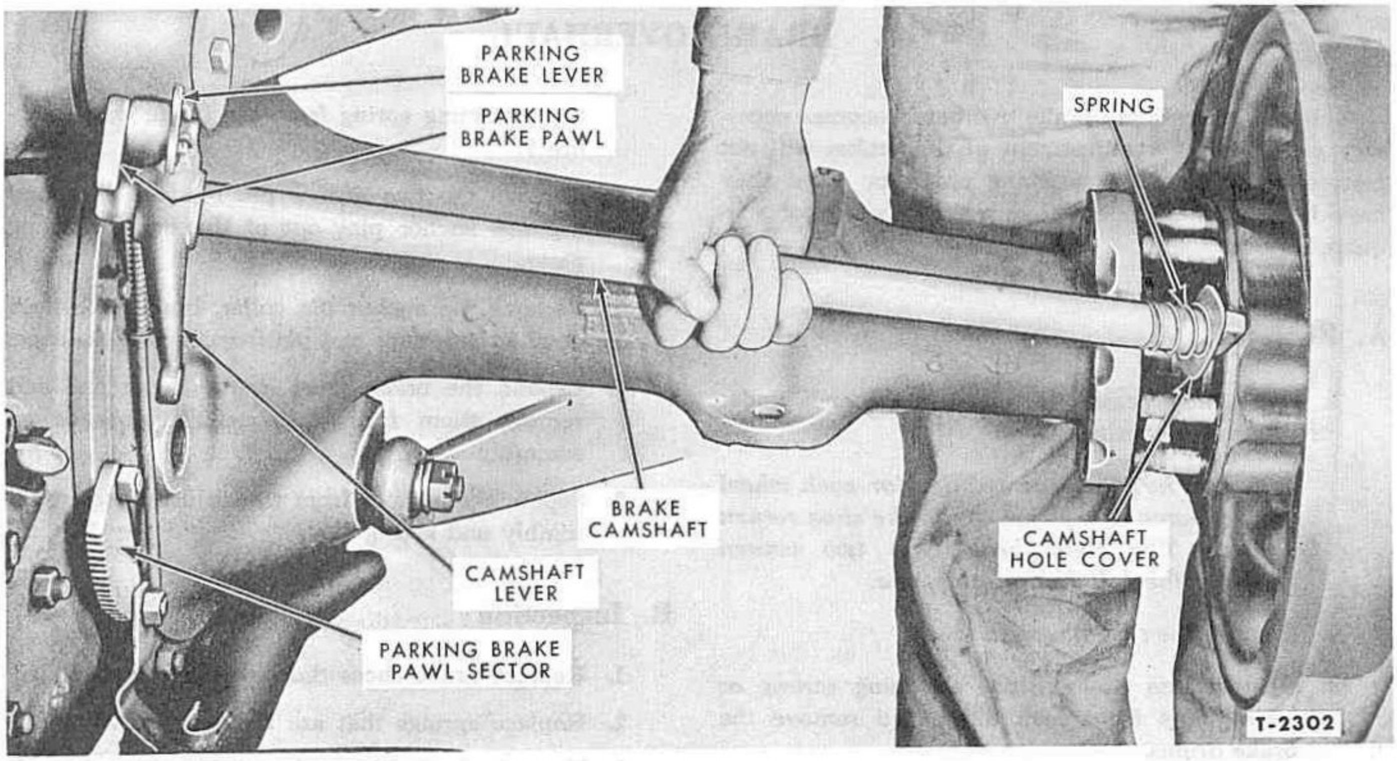


Figure 6—Removing Brake Camshaft Assembly

3. BRAKE CAMSHAFT

A. Removal

It will be necessary to remove the brake camshaft to replace the right brake pedal, either parking brake lever or either camshaft lever, Figure 4.

1. Disconnect the parking brake pawl control rod from the parking brake lever, Figure 5.
2. Disconnect the brake rod from the camshaft lever (left side only). Disconnect the taillamp wire from the clamps on the camshaft (left side only).
3. Raise the tractor until the rear wheel just clears the floor. Remove the nuts that attach the rear axle bearing retainer to the axle housing "All Purpose" tractor. Remove the nuts that attach the final drive housing to the axle housing "Row Crop" tractor.
4. Slide the rear wheels out just far enough to free the inner end of the camshaft from the center housing.
5. Carefully work the camshaft out of the brake backing plate, Figure 6.

B. Installation

1. Transfer all serviceable parts from the old camshaft onto the new one as shown in Figure 4. After the Woodruff key and lever is installed, torque the bolt to 60-80 ft. lbs.
2. Coat both ends of the camshaft with a light film of Lubriplate.
3. Work the flat end of the camshaft into place in the brake backing plate. Align the ball end with the socket in the center housing. Push the wheel inward until the ball on the camshaft is seated in the socket.
4. Install and tighten the axle shaft bearing retainer or final drive attaching nuts to 130-150 ft. lbs. torque.
5. Connect the brake rod to the camshaft lever with a clevis pin and cotter pin (left side only). Connect the taillamp wire and secure it to the camshaft with two attaching clamps (left side only).
6. Connect parking brake control rod to the parking brake lever with the retaining clip.

4. BRAKE OVERHAUL

A major or complete brake overhaul becomes necessary only when a readjustment of the brakes will not restore them to proper working order, or when they have been allowed to deteriorate through lack of adequate service.

A. Removal

1. Raise the tractor and install jack stands under the rear axle housing.

   NOTE: ***The brake assemblies for each wheel are the same except for the brake shoe return springs. The right brake has two return springs; the left brake, only one.***

2. Remove the rear wheels.
3. Remove the brake drum attaching screws or spring nuts from each drum and remove the brake drums.
4. Disconnect the brake shoe return springs and the retracting spring from the brake shoes, Figure 7.
5. Remove the two anchor pin retainer clips and slip the anchor pins out of the brake backing plate.
6. Remove the anchor pin collar, brake shoe hold down spring, cups and pin from each brake shoe.
7. Expand the brake shoes at the upper end and remove them from the backing plate as an assembly.
8. Separate the shoes from the adjusting screw assembly and spring.

B. Inspection

1. Replace brake shoes that are worn or damaged.
2. Replace springs that are broken or distorted.
3. Turn the brake drums in a brake drum lathe if scored.

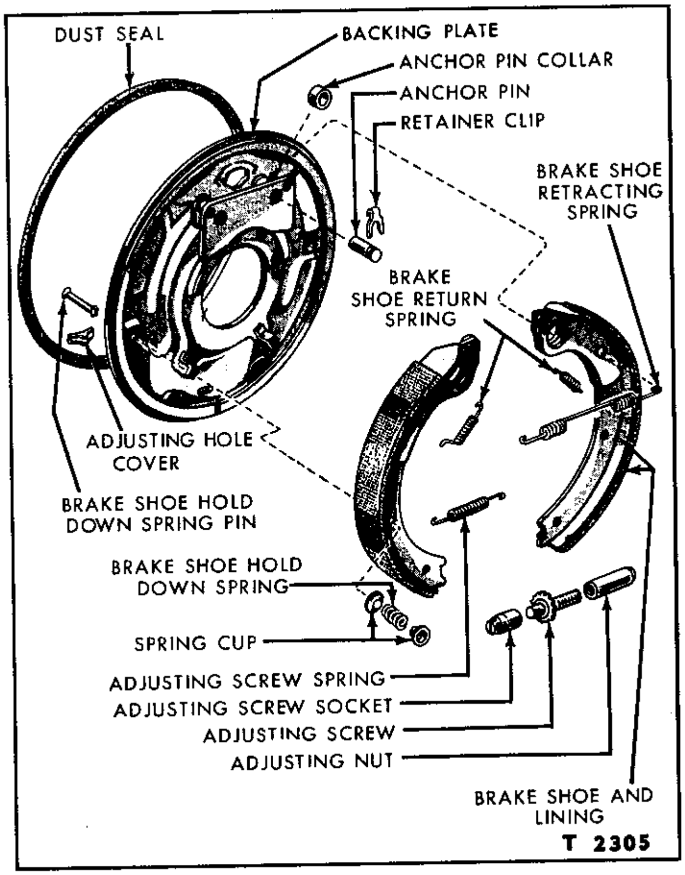


Figure 7—Brake Shoes and Related Parts

IMPORTANT: ***Do not remove stock in excess of 0.050".***

4. Replace worn anchor pins or damaged retainer clips.

C. Installation

1. Lubricate the shoe bosses on the brake backing plate with Lubriplate. Also, apply a light film on the shoes where they contact the anchor pin collars. Lubriplate the adjusting screws.
2. Connect the adjusting screw spring, Figure 7, to each shoe, then install the adjusting screw assembly. Position an anchor pin collar in each shoe.
3. Position the brake shoes on the backing plate and install the brake shoe hold down spring pin, spring and two cups on each shoe as shown in Figure 7.
4. Install the two anchor pins and retainers.
5. Install the brake shoe retracting spring and return springs.
6. Install the brake drums and secure each drum with the attaching screws or spring nuts.
7. Install the rear wheels and adjust the brakes as detailed on page 362.

Part THREE

STEERING, FRONT AXLE, BRAKES, WHEELS AND TIRES

Chapter

IV

Wheels and Tires

Section Page
1 Wheel Bearings 369
2 Wheel Spacing–Tread Width 369
3 Wheel Weights 375
4 Tires 378
5 Specifications 379
6 Special Tools 380

The front wheels on Ford Tractors are of the pressed steel disc type, and are equipped with pneumatic tires. Each front wheel is mounted on a hub provided with two tapered roller bearings. There are several different rear wheels available for the Ford Tractor as detailed in the REAR WHEEL CHART below. To meet the various operating conditions, the tread width of both the front and rear wheels may be adjusted (excluding single front wheel "Row Crop" and "Industrial" tractors). With the exception of the 600 lb. weighted wheel, weights may be used on the wheels. Calcium chloride may be added in the tires to provide additional traction.

REAR WHEEL CHART

RIM SIZE	RIM PART NO.	DISC PART NO.	SERIES APPLICATION	REMARKS
8 x 42	310715	NCA-1122-A	700, 701, 900, 901	High Clearance Tractors
9 x 28	NCA-1020-C	NCA-1122-A	600 thru 801	
9 x 38	313559	313555	700, 701, 900, 901	High Clearance Tractors
10 x 28	NCA-1020-B	NCA-1122-A	600 thru 1801	
10 x 28	NCA-1020-B	312223	800, 801, 1801	Available only as production option
11 x 28	NDB-1020-B	NDB-1122-B	600 thru 901	Power adjusted wheels, standard on 900-901, optional on 600 thru 801*
11 x 38	313953	313555	700, 701, 900, 901	High Clearance Tractors
12 x 24	311724	311701	600, 601, 800, 801, 1801	
12 x 28	313197	NCA-1122-A	800, 801, 1801	

*With spacer.

1. WHEEL BEARINGS

The front wheel hubs on all models are mounted on the wheel spindles by inner and outer tapered roller bearings. Starting with Serial No. 137818, a new front wheel hub was used on the "General Purpose" tractors. The overall dimensions of the wheel bearings used in the new hub are different than the bearings previously used. However, the complete hub assemblies are interchangeable on the spindles. A grease seal is provided at the inner end of the hub, and a threaded hub cap at the outer end, to exclude dirt and retain the lubricant.

NOTE: *The hub caps on "Industrial" models are friction type caps and are driven into the hub instead of being threaded.*

The rear wheel bearings on all models of the Ford Tractor are tapered roller bearings. Each bearing is enclosed in the bearing retainer. Rear wheel bearing removal may be necessary at the time of rear axle overhaul. The procedure for replacing the rear wheel bearings is detailed on Page 259 under REAR AXLES.

A. Front Wheel Bearing Adjustment

To check wheel bearing adjustment, jack up the front of the tractor, grasp the tire at the sides and move it in and out. If any looseness is felt, adjust the front wheel bearings as follows:

1. Remove the hub cap.
2. Remove the cotter pin from the wheel bearing nut.
3. Tighten the nut while rotating the wheel back and forth, until a noticeable drag is felt. This will properly seat the bearings in the bearing cups.
4. Back off the retaining nut until the nearest slot in the nut is in alignment with the hole in the spindle (about 1/6 to 1/4 turn). Lock the nut in this position with a new cotter pin.
5. Install the hub cap and tighten it securely.

B. Front Wheel Bearing Replacement

1. Remove the hub cap from the outer end of the spindle.
2. Remove the cotter pin, the wheel bearing nut, and flat washer.
3. Slide the wheel and hub assembly off the spindle carefully, until the outer bearing is near the end of the spindle. Then, remove the outer bearing. Remove the wheel and hub assembly. Then, remove the grease seal and inner bearing from the hub.
4. If the bearing cups in the hub show signs of wear, scoring, or other damage, use a suitable puller to remove them.
5. Press the bearing cups carefully into the hub until they bottom.
6. Pack the inner bearing with M-46-64 wheel bearing grease and position it in the hub. Install the grease seal in the hub.
7. Slide the wheel on the spindle carefully, to avoid damaging the grease seal.
8. Pack the outer bearing with grease and position it in the hub.
9. Install the flat washer and nut. Adjust the bearings and install the cotter pin. See A above. Install the hub cap.

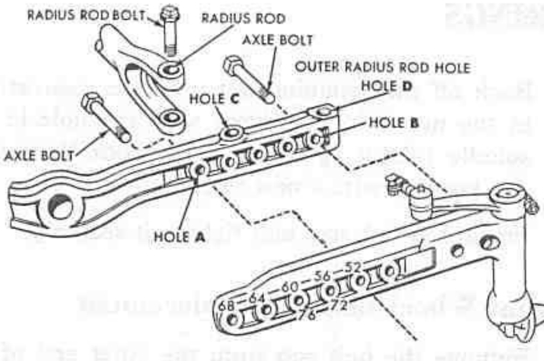
2. WHEEL SPACING—TREAD WIDTH

All front wheels on Ford Tractors with the exception of the single wheel "Row Crop" and "Industrial" models, are adjustable. The design of the Ford Tractor permits adjustments to meet most requirements. The front wheel tread width on dual wheel "Row Crop" tractors is normally 8.3 inches. By changing the wheels so that they dish out instead of in, the tread width can be increased to 16.3 inches.

When working listed crops, the wide setting will make it easier to keep the front wheels on the ridges. It will also prevent the accumulation of mud between the wheels in wet or sticky soil.

A. Front Wheels

The adjustment procedure for the front wheels on "Row Crop" tractors equipped with an adjustable axle



FOR TREAD WIDTH (INCHES)	LINE UP HOLE **A** AND HOLE NO.	LINE UP HOLE **B** AND HOLE NO.	SPACE BOLTS APART (INCHES)	SET RADIUS ROD TO HOLE	RADIUS RODS SPREAD (INCHES)
52	52		8½	**C**	29.08
56	56		8½	**C**	29.08
60	60		6⅜	**D**	40.82
64	64		8½	**D**	40.82
68	68		8½	**D**	40.82
72		72	6⅜	**D**	40.82
76		76	4¼	**D**	40.82
80†		72	6⅜	**D**	40.82

† REVERSE WHEELS ON AXLE HUBS.

NOTE: ADJUST DRAG LINKS—SEE FRONT WHEEL TOE-IN

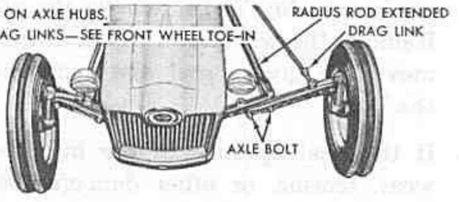


Figure 1—Front Wheel Tread Adjustments—General Purpose Tractors

is the same as the "General Purpose" tractors with the exception of the tie rods. The front wheels are adjustable from 52 to 76 inches in 4 inch increments. To change the tread width, proceed as follows:

1. Raise the front of the tractor until the wheels clear the ground. Remove the two bolts from one axle, Figures 1 and 2.

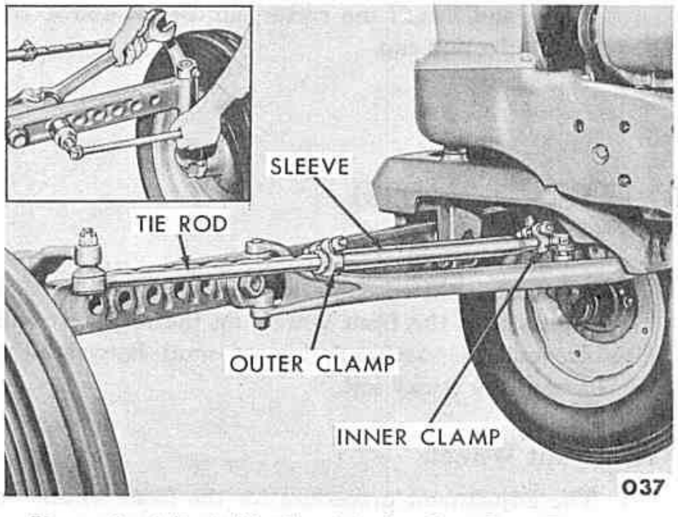


Figure 2—Adjustable Front Axle—Row Crop Tractors

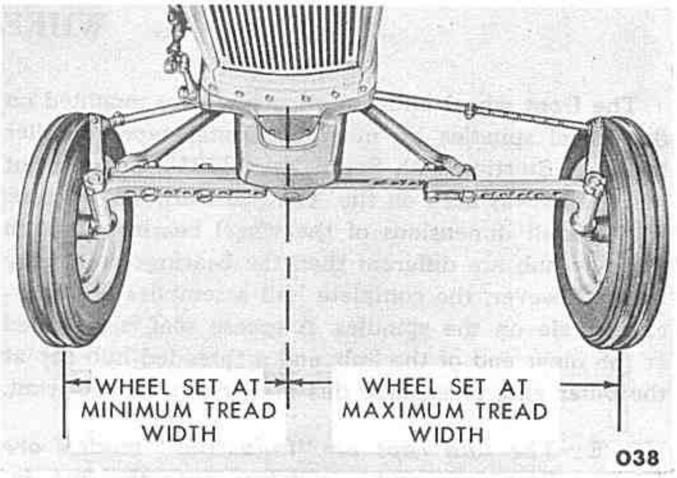

WHEEL SET AT MINIMUM TREAD WIDTH
WHEEL SET AT MAXIMUM TREAD WIDTH
038

Figure 3—Front Wheel Tread Adjustments—Row Crop Tractors

Row Crop Models: Remove the bolt and lock washer from the tie rod outer clamp, Figure 2.

2. Position the axle at the desired tread width and install the two axle attaching bolts. Relocate the radius rod as necessary, Figure 1.

IMPORTANT: ***Always leave one or more open bolt holes between the axle bolts.***

Row Crop Models: Position the front wheel straight ahead and align the hole in the outer clamp with the

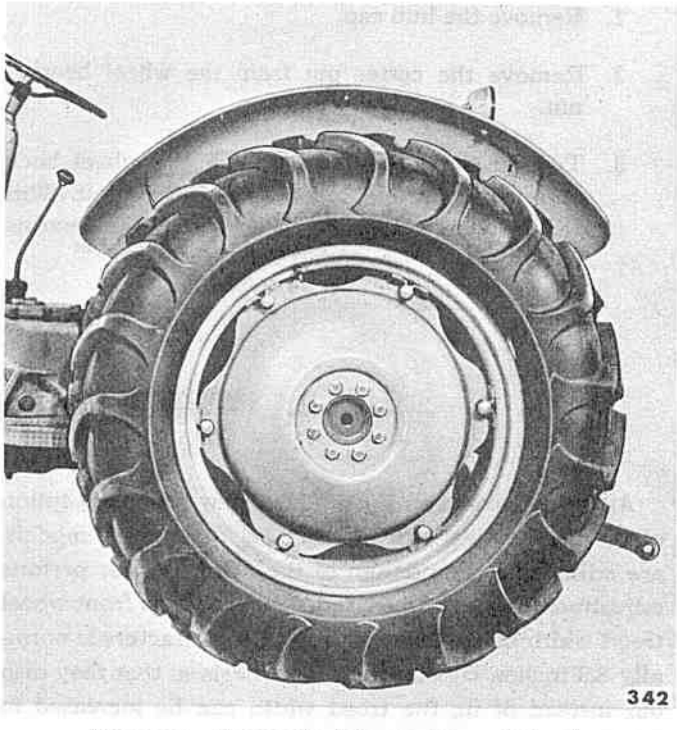


Figure 4—Manually Adjusted Rear Wheels

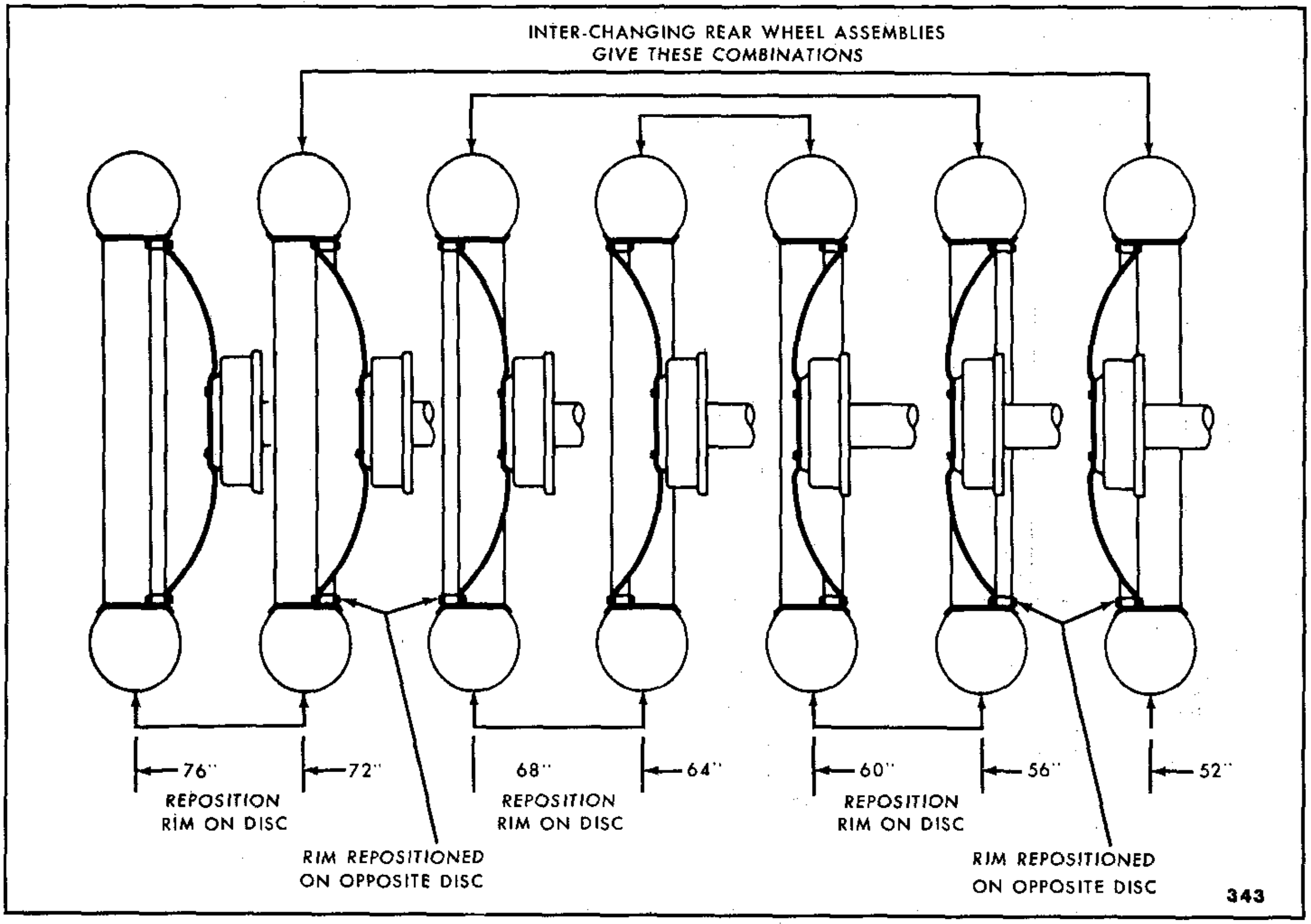


***Figure 5—Rear Wheel Tread Width Adjustments—
General Purpose Tractors***

groove in the tie rod nearest to the outer clamp hole, Figure 2. Install the bolt and lock washer to lock the tie rod in the sleeve.

NOTE: ***A tread width of 80 inches can be obtained by reversing the wheels (dish out) and setting the tread width at 72 inches.***

3. Check the front wheel toe-in and if necessary, adjust to ¼-½ inch as detailed on page 355.

B. Manually Adjusted Rear Wheels

Manually adjusted rear wheels are standard equipment on all 600 thru 801 Series tractors and all "Industrial" tractors. The wheel disc is secured to the rim by six bolts, Figure 4, and may be adjusted for the desired tread width as follows:

1. Support the tractor with a jack and remove the wheel.

   NOTE: ***When changing tread width, particular attention should be given to the position of the wheel disc (whether it is inside or outside of the rim lugs), as this will affect the tread width.***

2. Remove the six bolts and nuts and position the rim as desired. Refer to Figure 5 for "General Purpose" tractors, Figure 7 for "Industrial" tractors, or Figure 6 for "Row Crop" tractors, to obtain proper location of rim for desired tread width. Install the six rim bolts, lock washers, and nuts, and tighten them securely. Install the wheel on the tractor and repeat this procedure for the other wheel.

C. Power Adjusted Rear Wheels

Power adjusted rear wheels are standard equipment on all 900 and 901 Series tractors. Power adjusted rear wheels are available as optional equipment on 600 thru 801 Series tractors. It is essential that a Rear Axle Extension, Part No. NCA-1222-A be used between the end of the axle and wheel on

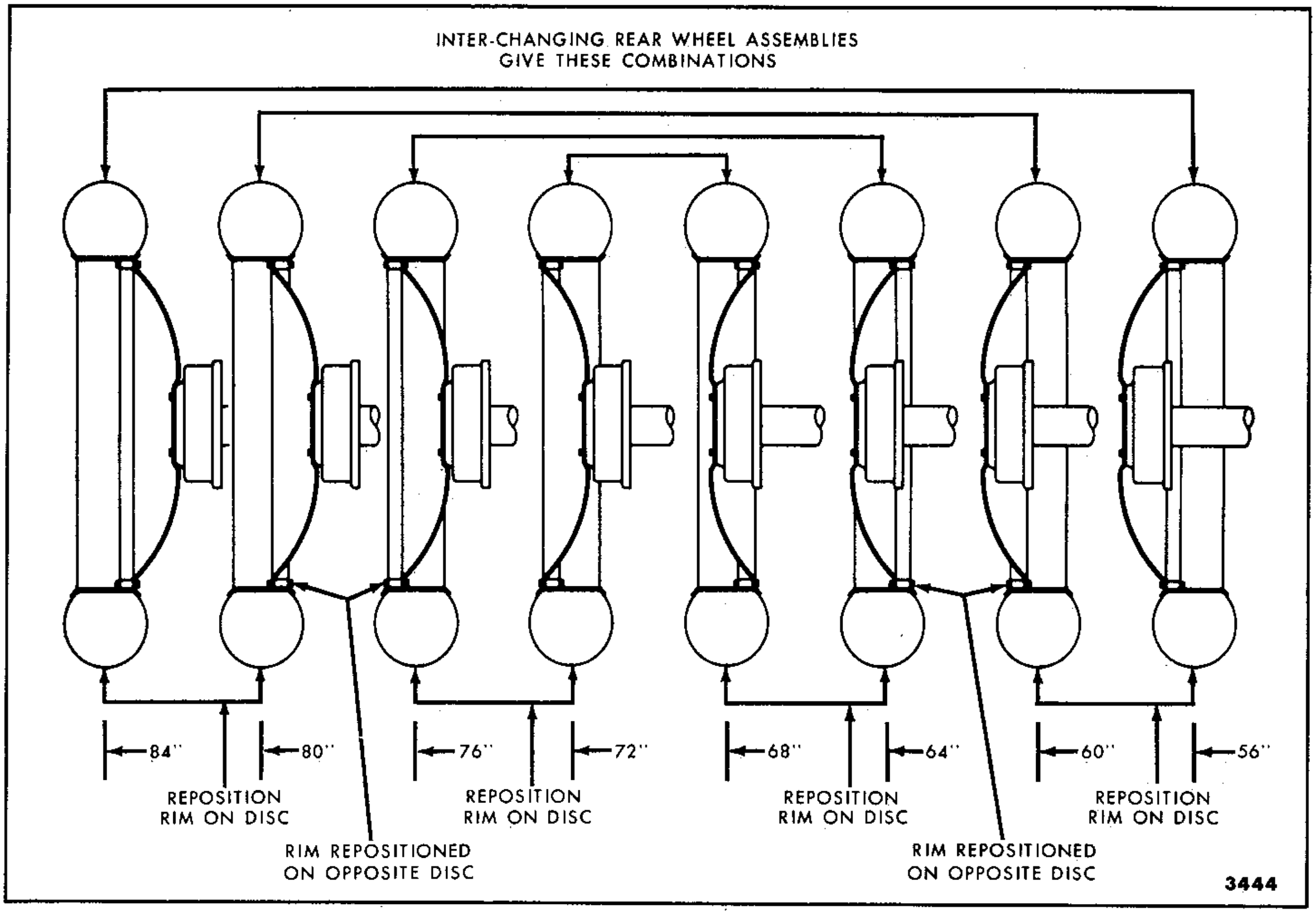


Figure 6—Rear Wheel Tread Width Adjustments—Row Crop Tractors

"General Purpose" tractors equipped with power adjusted wheels. The extension will prevent interference between the wheels and fenders when the wheels are set at the minimum width.

The rear wheels may be moved to any desired width in the tread range of 56 to 76 inches without raising the tractor wheels, Figure 8. Tread widths of 64 to 84 inches can be obtained by reversing the wheels, Figure 9. Engine power is utilized to move the wheel in and out.

Changing the tread width with a power adjusted wheel is similar to turning a bolt in a nut. The rim acts as the nut, with slotted channel bars which serve as threads. The wheel disc acts as a bolt, having a helical shape with a 2 inch pitch. *Each wheel must be adjusted separately.* The different tread widths possible with the power adjusted wheel are shown in Figure 8. Each complete revolution of the wheel changes the tread width 2 inches. By placing the spacer clamp in other channels on the rim, spacings in ½ inch increments can be made as follows:

1. Position the wheel so that the spacer clamp is at the top of the wheel as shown in Figure 10.
2. Loosen the nut on each of the three locking clamps, Figure 10. Slide the clamps toward the hub of the wheel and then tighten the nuts to hold the clamps in this retracted position.
3. Loosen the large nut on the spacer clamp. Loosen the small knurled nut and turn the small bolt so that the special head will come through the opening in the wheel disc. Remove the large nut and remove the clamp from the wheel.
4. Place the spacer clamp in the channel thread bar for the desired setting, as shown in Figure 8. Insert the oval head bolt in the channel slot, turn it so that the bolt head is secure in the

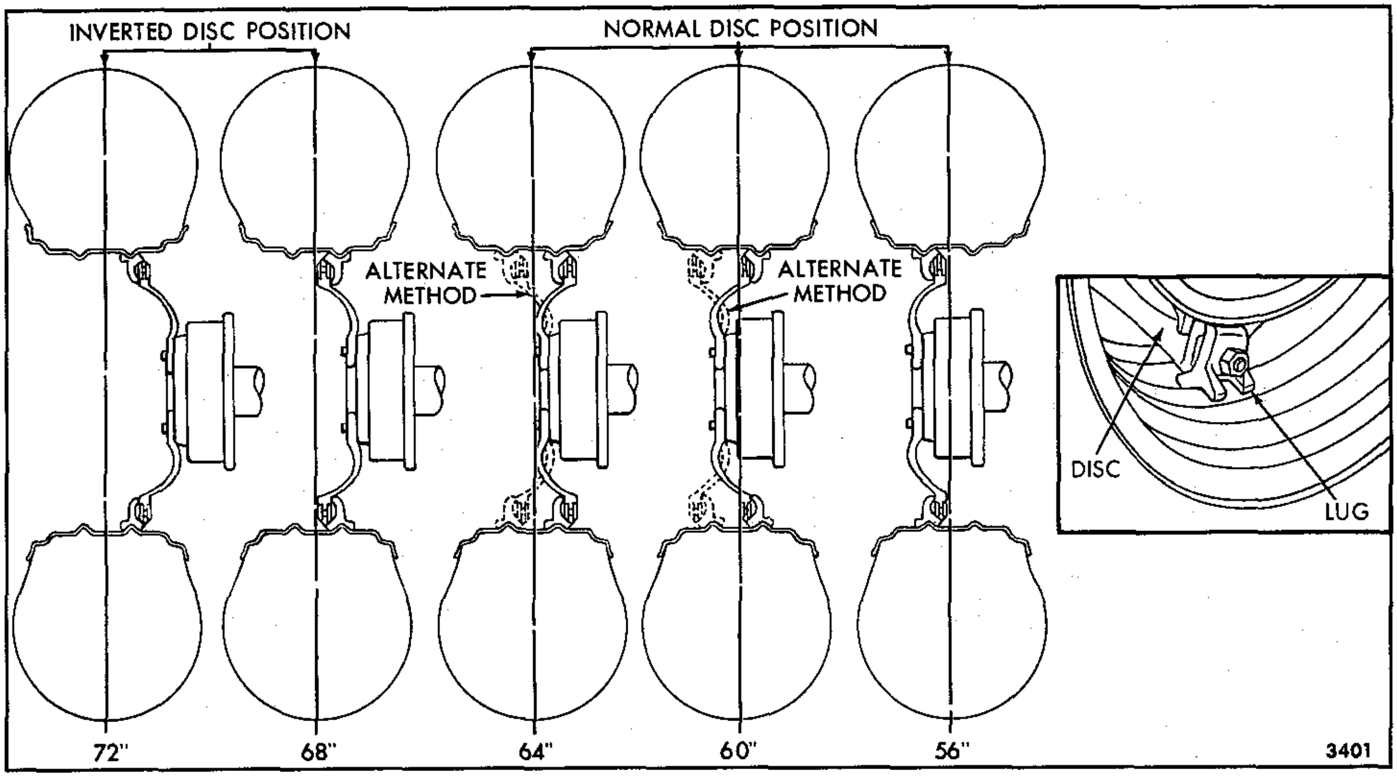


Figure 7—Rear Wheel Tread Width Adjustments—Industrial with 24" Cast Wheels

channel slot. Be sure the knurled nut is tightened securely.

5. Move the wheel by engaging the transmission with the engine at idle speed. Brake the opposite wheel and let the tractor creep while the wheel disc is revolving, then disengage the transmission immediately when the wheel strikes the spacer clamp, Figure 12.

6. Move the tractor so that the spacer clamp can be replaced at the top of the wheel.

7. Remove the spacer clamp from the channel bar by loosening the knurled nut and turning the slotted bolt ¼ turn.

8. Use the spacer clamp as the fourth wheel locking clamp. Place the clamp on the bolt with the lug in the holding slot and the small bolt head through the wheel disc. Install the large nut and washer and tighten the nut securely. Tighten the small knurled nut. The spacer clamp used as a driver clamp is shown in Figure 11.

9. Loosen the nuts on the three driver clamps and move them into the driving position in the thread channel. Tighten all clamp nuts securely.

NOTE: ***Effective with Serial No. 121557, an improved rear wheel was used. All older wheel parts are interchangeable with the new wheel with the exception of the wheel rim clamps. The wheel rim clamps must be used with their respective wheels.***

IMPORTANT: ***The clamp nuts should be tightened again after the tractor has been used for a short period of time.***

D. Changing Rear Wheel Discs

When wheel settings greater than 76" are required, spacings of 80 or 84 inches can be obtained. Set the spacing at 56 inches for 84 inch wheel spacing, and 60 inches for 80 inch spacing; then, reverse the wheels on the tractor as follows:

1. Loosen the wheel lug nuts at each rear hub.

2. Raise the rear of the tractor and be sure it is firmly supported.

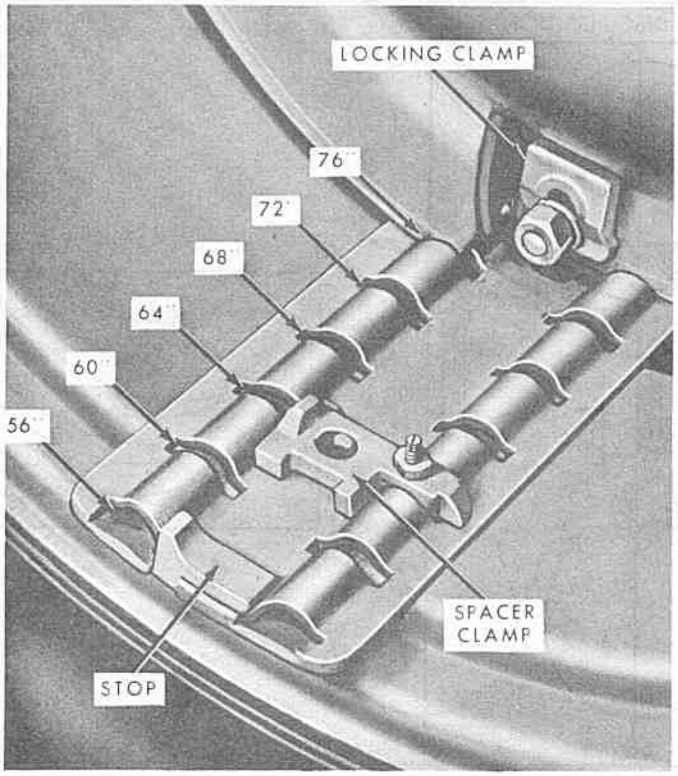


Figure 8—Tread Width Adjustments

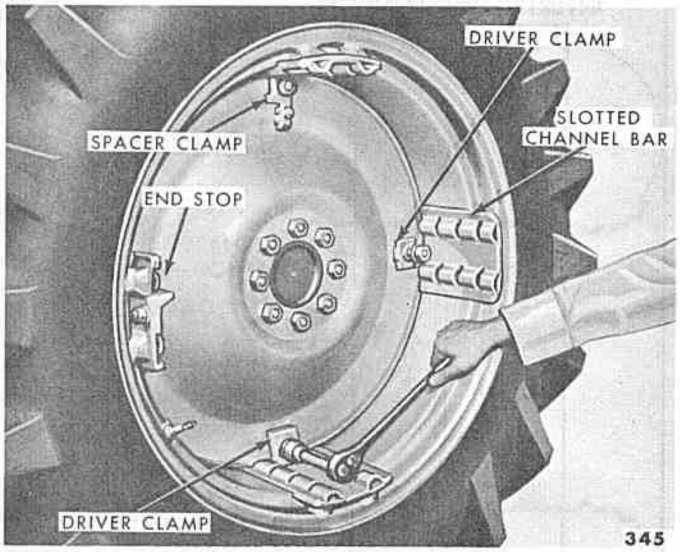


Figure 10—Preparing to Adjust Wheel

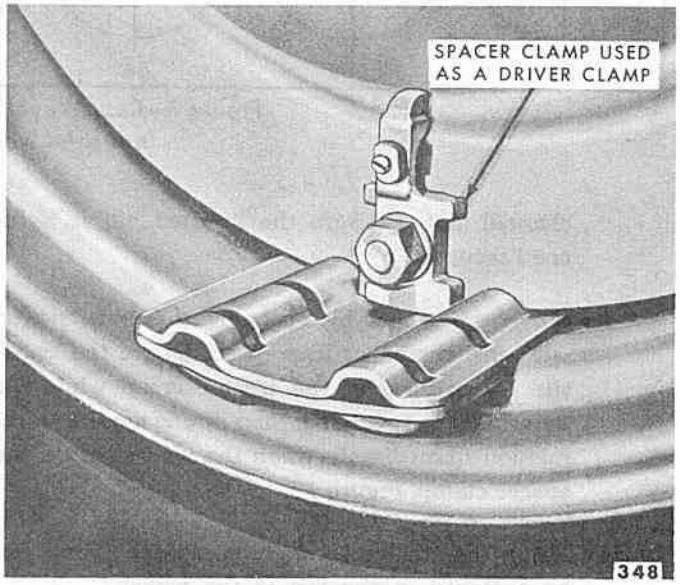


Figure 11—Spacer Clamp Used as Driver Clamp

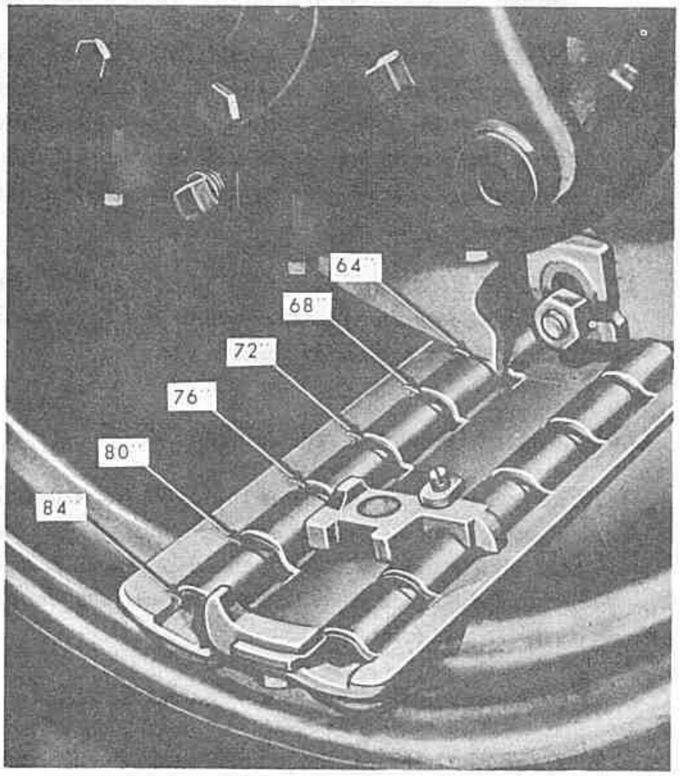


Figure 9—Tread Width Adjustments—Wheels Reversed

3. Interchange the wheels, so that they dish in. The arrow on the side wall of the tire should always point in the direction of forward rotation of the wheel.
4. Install all the lug nuts and tighten them securely.

NOTE: ***With the wheels reversed (dished in), it will be necessary to work from the inside of each wheel when making adjustments, Figure 9. Refer to Power Adjusted Rear Wheels for the detailed procedure.***

3. WHEEL WEIGHTS

Wheel weights are available for use on both the front and rear wheels of all Ford Tractors except the "Industrial" models. Only the rear wheel weights are provided for "Industrial" models. Front wheel weights are easily attached with two bolts through each section. The front wheel weights come in two sections, each of which weighs 50 lbs. and covers half of the wheel. The weights mount on the inside of each front wheel. Additional wheel weights are now provided for rear wheel; Part No. 312223.

A weight box, which can be mounted on the front of "Row Crop" tractors equipped with single or dual wheels, is also available.

Wheel weights are not used on the front wheels of the Ford Industrial Tractor.

A. Rear Wheel Weights

Rear wheel weights are available in two sizes; Regular Duty Weights weighing 30 lbs. each and Heavy Duty Weights weighing 45 lbs. each. The regular or heavy duty weight segments can be used on the standard 12x 28 rear wheels. The Regular Duty Weights add 800 lbs. to the tractor when a mounting plate and 12 segments are installed on each wheel. The Regular Duty Weights are recommended for use on Series 600, 601, 700, 701, 900, and 901 tractors. Heavy Duty Weights, for Series 800 and 801 tractors only, add 1160 lbs. to the tractor when a mounting plate and 12 segments are installed on each wheel. The weight mounting plates weigh 68 lbs. There are optional 13 x 24 and 14 x 24 rear wheels which incorporate malleable cast iron wheel discs. Regular duty wheel weights can be used with these discs providing that the wheels are set for 56" tread width spacing and two each NCA-1222-A, 4 inch wheel extensions are used on each wheel. Both Regular Duty and Heavy Duty Weights are mounted as follows:

1. Remove one wheel lug nut, and install the weight mounting plate stud as shown in Figure 13. Repeat this procedure until all lug nuts are replaced, then tighten the plate studs securely.
2. Position the weight mounting plate on the studs with one of the raised ears on the plate centered on the valve stem. Install the lug nuts previously removed as shown in Figure 14, and tighten them securely.
3. Install each weight on the plate with the bolt provided, Figure 15. Do not tighten the bolts until all desired weights have been installed, then tighten all bolts securely.

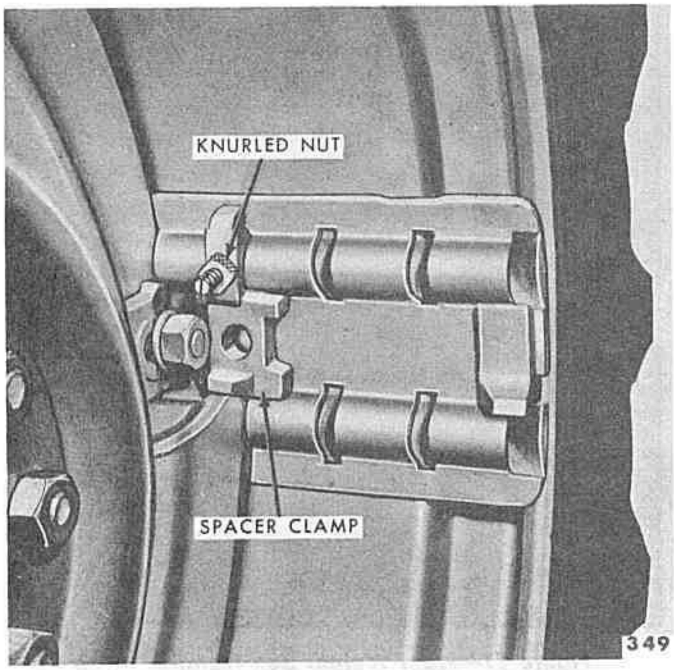


Figure 12—Wheel Disc Against Spacer Clamp

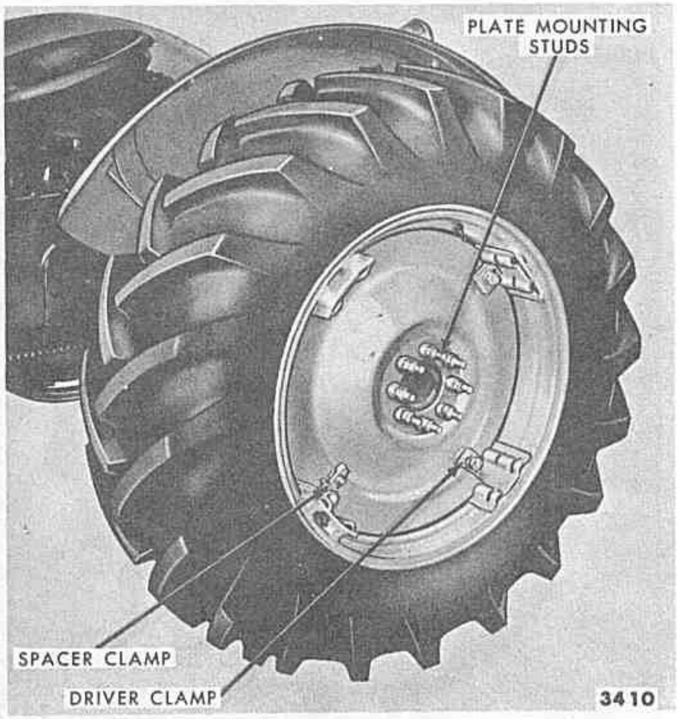


Figure 13—Weight Mounting Disc Studs Installed

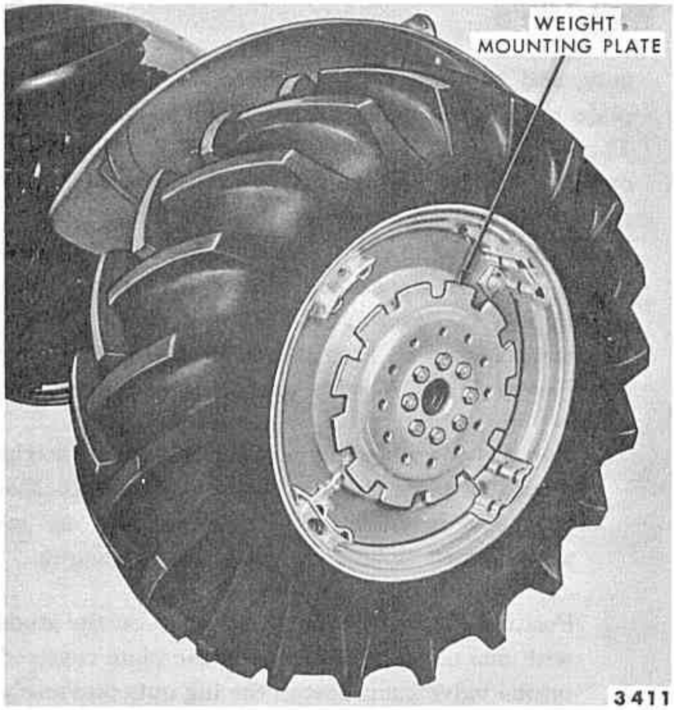


Figure 14—Weight Mounting Plate Installed

NOTE: *The weights can be mounted to give a little added weight or full weight; however, they must be added so that the wheel remains balanced. Three different combinations are shown in Figure 16.*

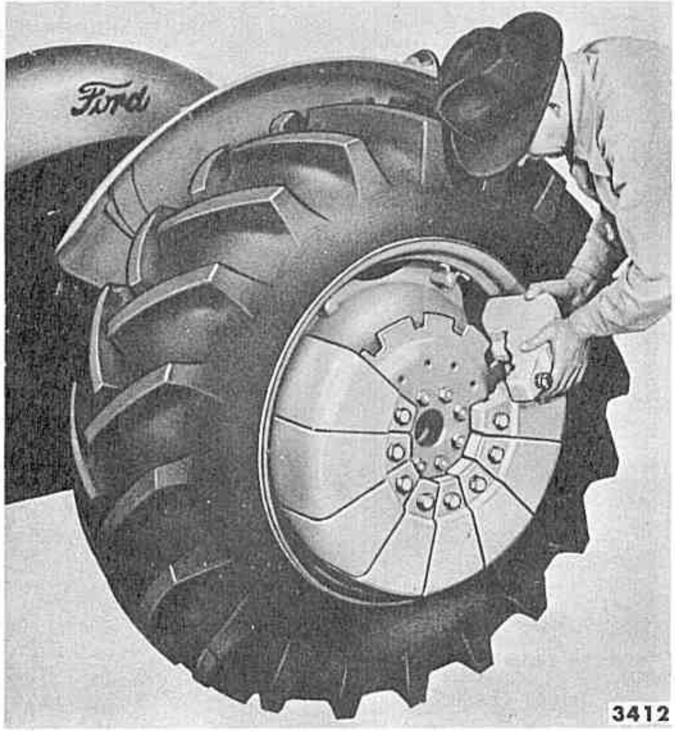


Figure 15—Installing Weights on Plate

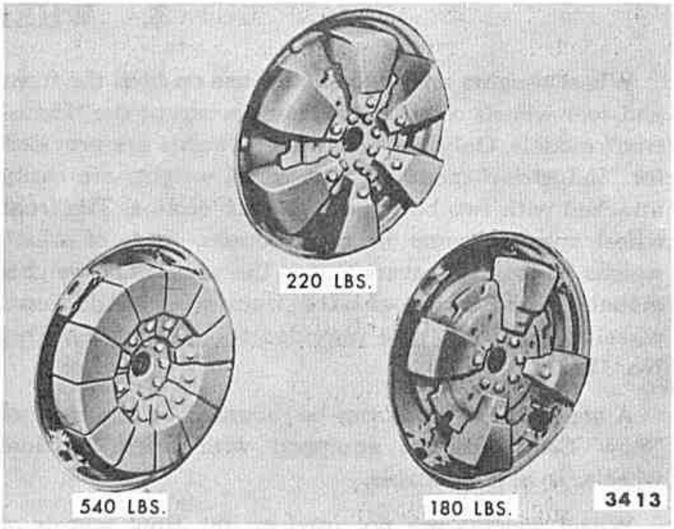


Figure 16—Wheel Weight Combinations

Weights can be removed one at a time, or by removing one weight and installing an eye bolt in the weight mounting hole for attaching the mounting plate to a hoist. If a hoist is used, merely remove the mounting plate lug nuts and swing the entire weight assembly away from the wheel. Replace the mounting plate studs one at a time with the wheel lug nuts and tighten all lug nuts securely.

B. Weight Box

The weight box for single or dual wheel "Row Crop" tractors is secured to the front of the pedestal with

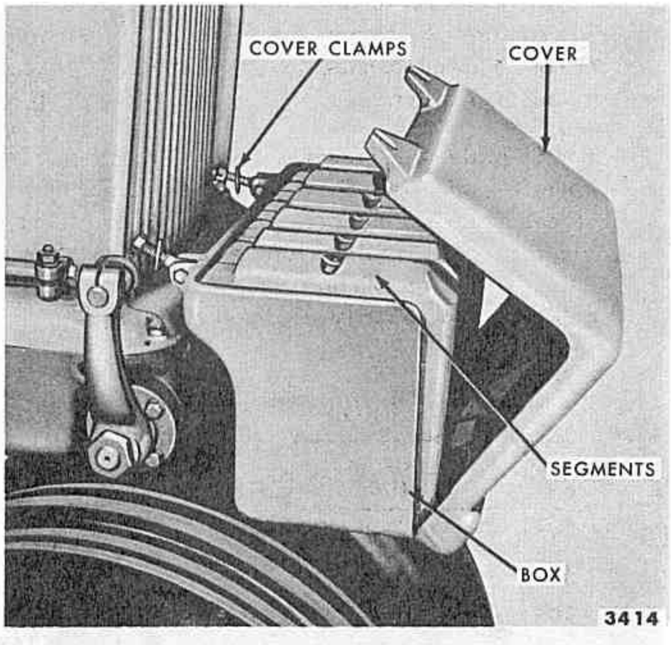


Figure 17—Front Weight Box Installed—Row Crop Tractors

4 bolts. The box weighs 130 lbs. and the inside is channeled for adding up to six weights of 48 lbs. each. The cover is hinged at the bottom front of the box and is secured with 2 bolts as shown in Figure 17.

The weight box, when loaded, adds approximately 420 lbs. to the front of the tractor.

FORD TRACTOR WHEEL WEIGHTS

FORD TRACTOR WHEEL WEIGHTS	SERIES 600-601		SERIES 800-801		SERIES 700-701	SERIES 900-901
	Farm Use	Industrial Use	Farm Use	Industrial Use	Standard Wheels	Power Adj. Wheels
FRONT (Per Tractor Set) Wheel Weights—Inside mounted Two per wheel—50 lbs. each Total—200 lbs.	X	X	X	X	*	*
REAR (Per Tractor Set) Regular Duty Weights Two Mounting Discs—34 lbs. each Segments—(24) 30 lbs. each Bolts—12 lbs. Total—800 lbs.	X	X			X	X
*Heavy Duty Weights Two Mounting Discs—34 lbs. each Segments—(24) 45 lbs. each Bolts—12 lbs. Total—1160 lbs.			X	X		

*Use Front Weight Box on Single and Dual Wheel Row Crop—Box weighs 130 lbs. Six Segments—48 lbs. each—Total 420 lbs. with weight box attaching bolts.

C. Liquid Weighting Tires

One of the most commonly used methods of adding weight to tractors is to fill the tires with a calcium chloride solution. A calcium chloride solution is used because of its lower freezing point, and greater weight per gallon than water.

Calcium Chloride Anti-Freeze Solution: Protection to a temperature of —60° F. is obtained by mixing 5 lbs. of calcium chloride per gallon of water. This formula makes 1.25 gallons of solution. Never use more than 5 lbs. of calcium chloride per gallon of water. The liquid capacity of the tires with a 90% fill is as follows:

FRONT

Tire Size	Gals. of H_20	Lbs. of CA. CL_2	Total Weight
9:00 x 10—	9	45	120
5:50 x 16—	4.5	22.5	60
6:00 x 16—	5.2	26	69
6:50 x 16—	5.9	29.5	79
7:50 x 16—	9	45	120

REAR

Tire Size	Gals. of H_20	Lbs. of CA. CL^2	Total Weight
10:00 x 28—	24	122	324
10:00 x 38—	31	157	416
11:00 x 28—	32	160	426
12:00 x 28—	39	197	525
12:00 x 38—	51	257	685
13:00 x 24—	44	219	584
13:00 x 28—	49	246	648
13:60 x 28—	39	197	525
14:90 x 24—	44	219	584
14:90 x 28—	49	246	648

CAUTION: ***Toxic fumes and intense heat, caused by combining calcium chloride and water, may be injurious to the operator. Always put water in the barrel first and add the calcium chloride slowly, as outlined below:***

1. Fill a 55 gallon steel barrel with the proper amount of water for the tire being filled.

2. Add the calcium chloride slowly. Add 1 lb. of hydrate of lime per 100 lbs. of calcium chloride to prevent caking.
3. Use a wood paddle and mix thoroughly. Allow the solution to cool until you can hold your hand against the side of the barrel comfortably.

Filling and Emptying Tires: Several good types of equipment are available for use in filling and emptying tires. The exact procedure used will depend on the type of equipment available. For this reason, no attempt is made here to give detailed instructions on filling the tires.

CAUTION: ***No matter what type of equipment is used, be sure it is well grounded before any electrical connections are made.***

Maximum Weights: Weights added to the tires, together with the weight of the mounted implement and tractor, should not exceed the recommended weight to be carried by the tires. The table in Section 5 lists the maximum recommended weight that can be carried without overloading the tires.

4. TIRES

All Ford Tractors are equipped with either directional (cleats) or non-directional tires. Tire size, of course, varies according to tractor size. Tire removal and installation procedures are the same for front and rear wheels.

A. Tire Removal—Excluding Single Front Wheel

1. Remove the wheel from the tractor and deflate the inner tube completely.
2. Press the valve through the valve hole, toward the inside of the tire.
3. Loosen both tire beads from the wheel rim, with a tire iron and a heavy mallet as shown in Figure 18.
4. With the wheel lying flat, stand on the tire with your feet about 15 inches apart, opposite the valve, then force the bead seat into the drop center of the rim.
5. Insert two tire irons, about 8 inches apart, between the tire bead and the wheel rim near the valve, then pry the bead over the wheel rim.
6. Leaving the one tire iron in position, follow around the wheel rim with the other tire iron to remove the remainder of the bead. Remove the inner tube.
7. Turn the wheel over and block the rim up off the floor as shown in Figure 19. Pry the wheel out of the tire, starting with a small section and following around the wheel.

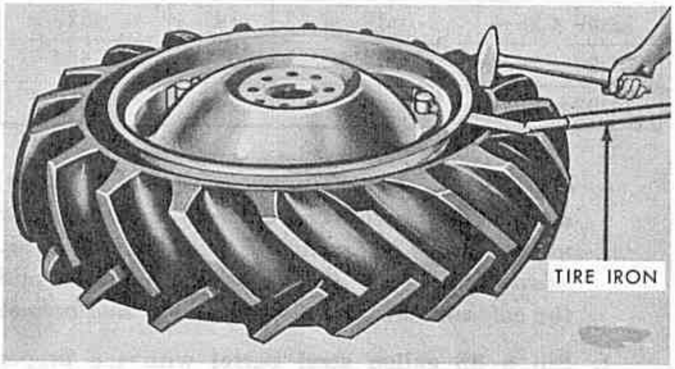


Figure 18—Loosening Tire Bead from Edge of Rim

B. Tire Installation—Excluding Single Front Wheel

1. Place the wheel and rim on the floor in a flat position.
2. Inflate the inner tube until it is barely rounded out, then install the tube in the tire.
3. Coat the inside and outside of the tire beads with a soap solution to protect the bead, then pry one bead over the edge of the rim.
4. Be sure the valve extends through the rim properly, then pry the other bead over the rim.
5. Inflate the tire to the recommended pressure or fill the tire with calcium chloride solution, as desired.

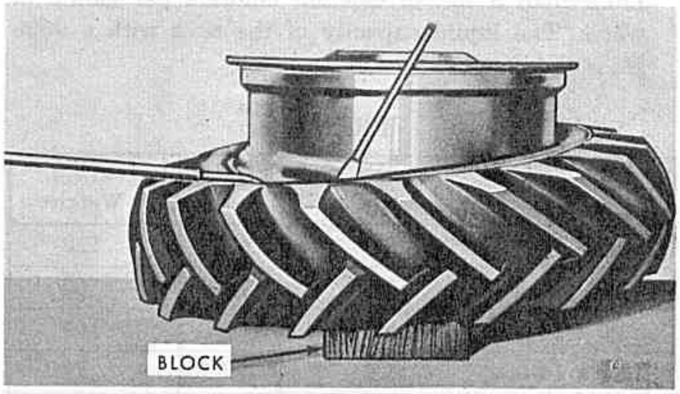


Figure 19—Prying Wheel Out of Tire

C. Tire Removal—Single Front Wheel

1. Raise the front of the tractor until the wheel is clear of the floor.
2. Turn the dust cap counterclockwise until it is free of the hub.
3. Remove the cotter pin, castellated nut, flat washer, and outer bearing.
4. Carefully remove the wheel from the spindle.
5. Remove the valve core from the inner tube to deflate the tire.

   CAUTION: ***Failure to remove all the air before disassembling the wheel could result in personal injury due to the rim halves flying apart.***

6. Remove the five bolts from the wheel and thread two of the bolts in the opposite side of the wheel. Turn the bolts in until the flange is free of the hub as shown in "A," Figure 20.
7. Remove the flange from the tire with tire irons as shown in "B," Figure 18.
8. Lift the tire off the hub and remove the tube liner and tube as shown in "C," Figure 20.
9. Remove the two bolts from the flange.

D. Tire Installation—Single Front Wheel

1. Install the valve core in the inner tube. Inflate the tube until it just starts to round out.
2. Install the inner tube and tube liner in the tire. Place the hub in the tire while guiding the valve stem through the hole provided in the hub.
3. Install the flange in the tire and rotate it as necessary to align the five bolt holes.
4. Install the five flange attaching bolts. Tighten the five bolts evenly and alternately.
5. Inflate the tube to 44 pounds pressure.
6. Position the wheel on the spindle and install the outer bearing, flat washer, and castellated nut.
7. Tighten the nut until a slight drag is felt while rotating the wheel, then back the nut off one castellation (⅙ to ¼ turn).
8. Install a cotter pin and the dust cap.

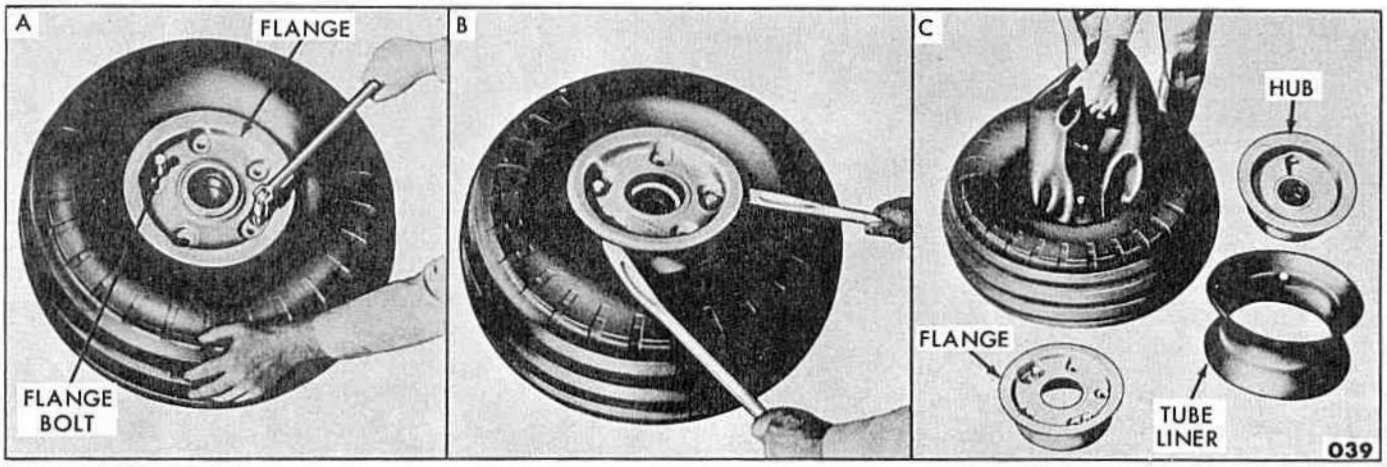


Figure 20—Removing Tire from Single Front Wheel

5. SPECIFICATIONS

Tire Size	Inflation Pressure	Maximum Lbs. Tire Load Per Wheel
REAR:		
10-28 4-ply	16	1860
10-38 4-ply	16	2155
11-28 4-ply	14	2070
12-28 4-ply	14	2430

Tire Size	Inflation Pressure	Maximum Lbs. Tire Load Per Wheel
REAR:		
12-38 4-ply	14	2420
12.4-28 4-ply	14	2070
13-24 4-ply	14	2470
13.6-28 4-ply	14	2430

Tire Size	Inflation Pressure	Maximum Lbs. Tire Load Per Wheel
REAR:		
14-24 6-ply	16	3560
14.9-24 4-ply	18	3125
14.9-28 4-ply	14	2630
FRONT:		
5:50-16 4-ply	28	1060
6:00-16 4-ply	20	755
6:50-16 6-ply	28	1050
9:00-16 8-ply	40	1620

Tire Size	Inflation Pressure	Maximum Lbs. Tire Load Per Wheel
FRONT:		
7:50-16 8-ply	44	2390

Tread Width

Series 601 and 801 front tire width	52-76 inches
*Series 601 and 801 rear tread width	52-76 inches
Series 701 rear tread width	56-84 inches*
Series 901 rear tread width	56-84 inches**

*Bolting disc to alternate rim flanges, reversing rim and reversing disc.

**Power Adjusted Wheels—discs reversed.

6. SPECIAL TOOLS

The special equipment required to service wheels and tires, is an electric liquid weighting pump and an air liquid pressure gauge. The tire repair department should be located near a water outlet for weighting the tires and should be provided with an overhead hoist to handle the wheels and tires safely and with a minimum of effort.

PART FOUR

HYDRAULIC SYSTEM

Chapter

I

Operating Principles

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1 Operating Principles 381

1. OPERATING PRINCIPLES

Figure 1, illustrates the Ford Tractor Hydraulic System. Mounted on the outside of the lift cover are the lift arms, touch control lever, selector lever, and the main control spring. The hydraulic pump is mounted on the right rear side of the tractor engine and is driven by a gear mounted on the rear of the camshaft.

The tractor center housing acts as the reservoir for the hydraulic system. The control mechanism such as

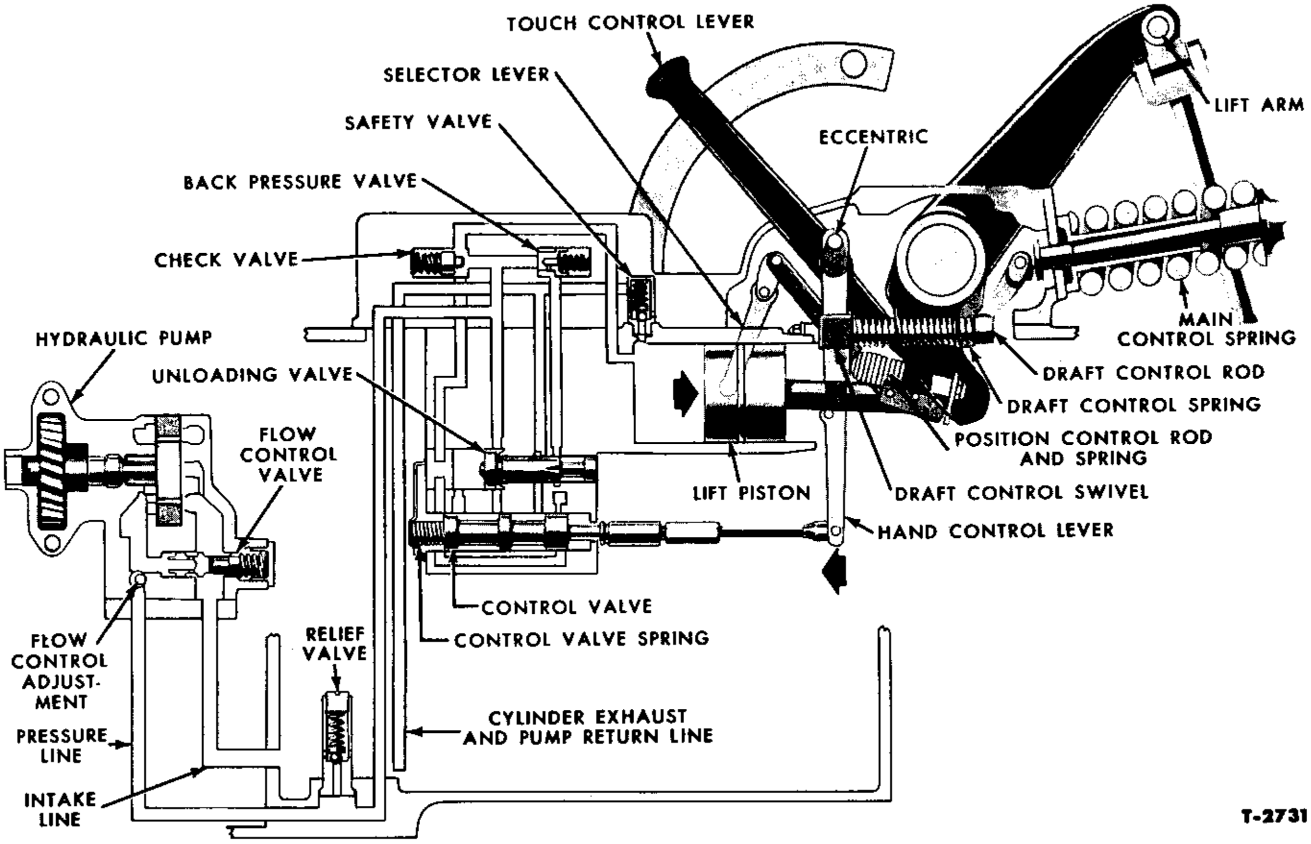

Figure 1—Hydraulic System—Draft Control Position

the various valves, linkage, and ram cylinder are located on the underside of the lift cover in the reservoir or tractor center housing.

A. External Controls

Touch Control Lever: Raising or lowering of the lift arms is controlled by the touch control lever located on the right side of the lift cover, Figure 1. Raising the touch control lever, pivots the hand control lever which moves the control valve through linkage, into the intake (forward) position. Oil is then pumped into the ram cylinder, to raise the lift arms or implement.

Lowering the touch control lever pivots the hand control lever which moves the control valve through linkage into the exhaust position (rearward), Figure 2. This will exhaust the hydraulic oil from the ram cylinder to lower the lift arms or implement.

Selector Lever: The selector lever (draft or position control) is located on the right side of the lift cover below the touch control lever, Figure 2. This lever permits the use of constant draft or implement position control. With this lever in the down position (draft control), the implement will be lowered to the ground as soon as the touch control lever is moved off the upper stop. However, after the tractor is in forward motion, the draft from the attached implement will automatically actuate the control valve through the tractor upper link to maintain a constant working draft on the tractor.

With the selector lever in the "UP" position (position control), the constant draft control is locked out by mechanical linkage. The lift arms or implement is then fully controlled by the movement of the touch control lever.

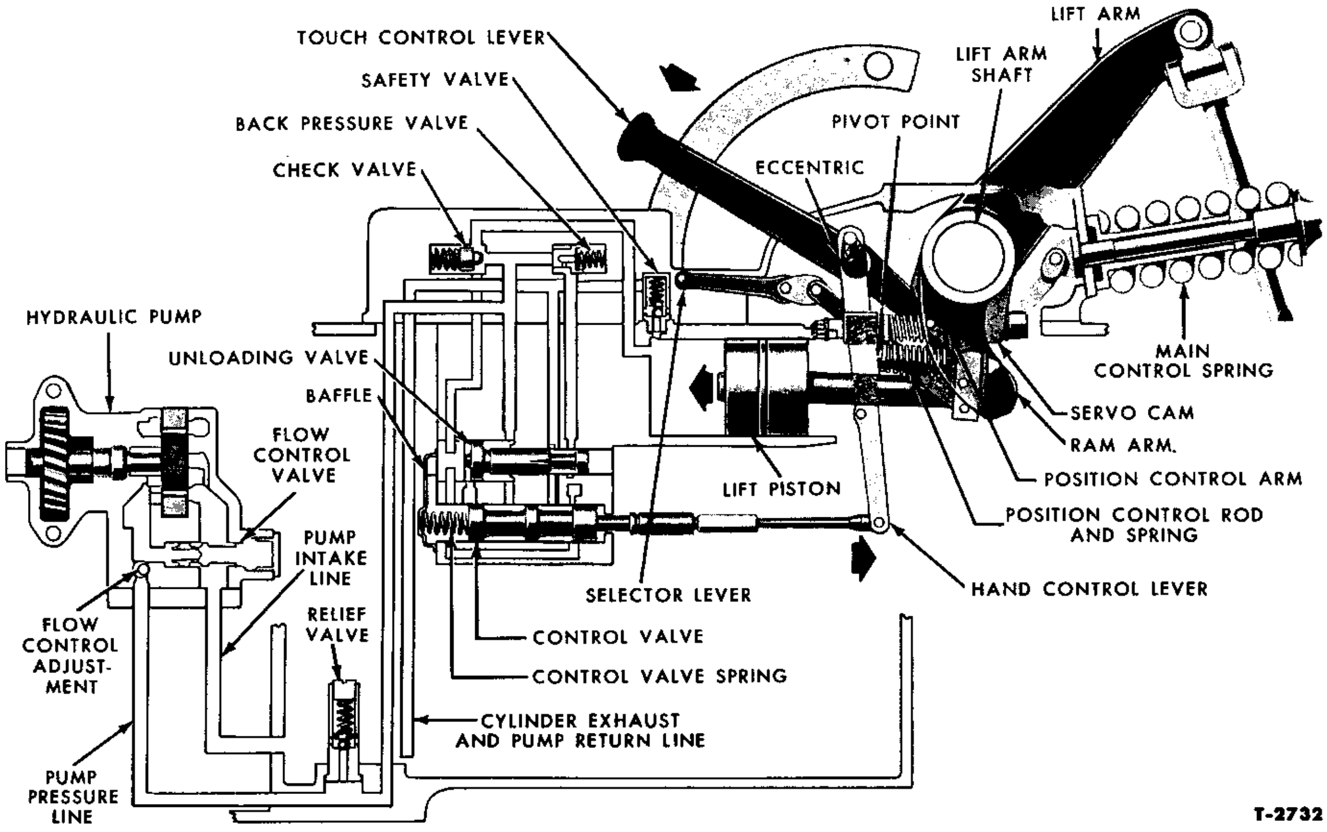

Figure 2—Hydraulic System—Position Control

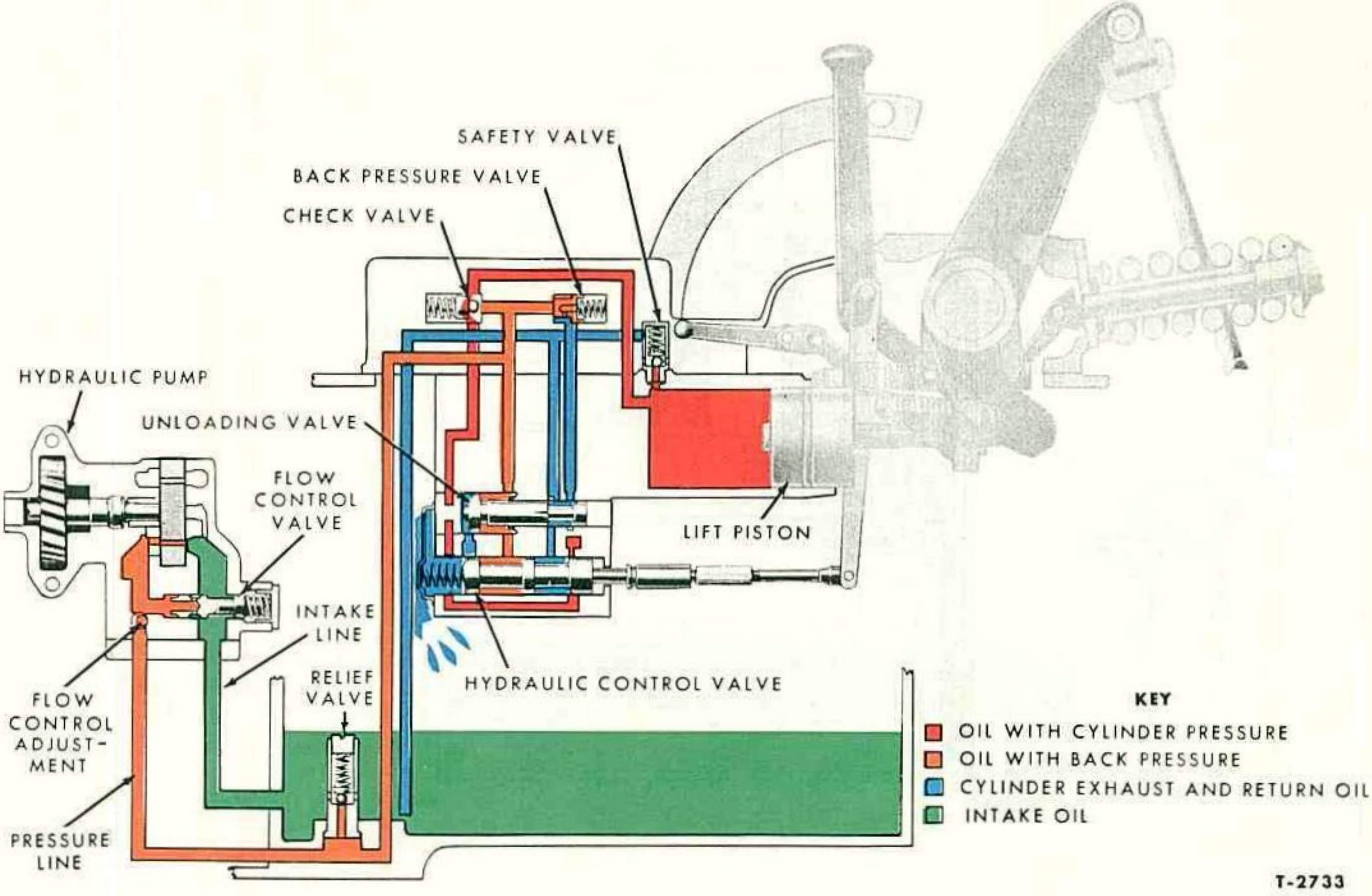

Figure 3—Oil Flow—Neutral Position

Moving the touch control lever downward allows the control valve to move to the rear under spring pressure. With the control valve in this position, the oil is exhausted from the cylinder until the cam contacts the hand control lever and returns the control valve to the neutral position.

The life arms will remain in this position until the touch control lever is moved to another position.

B. Hydraulic Control System Description

The hydraulic system consists of two major units, namely; the hydraulic pump and the lift cover. The lift cover incorporates the lift cylinder, the control valves and mechanical linkage. The function of each valve must be thoroughly understood to understand how the oil flow through the system is controlled. Following is the purpose and the function of each of the six valves in the system:

Relief Valve: The relief valve, Figure 2, protects the pump and the hydraulic system against pressure exceeding 2000 psi. This valve functions only when the pressure exceeds the maximum limit.

Check valve: The check valve, Figure 2, is a one-way valve designed to hold the oil in the lift cylinder and to hold the lift arms in a raised position. The valve operates only during a raising cycle. A pressure of approximately 115 psi is required to unseat the valve.

Safety Valve: The safety valve, Figure 2, is to protect the lift piston and cylinder from damage due to shock

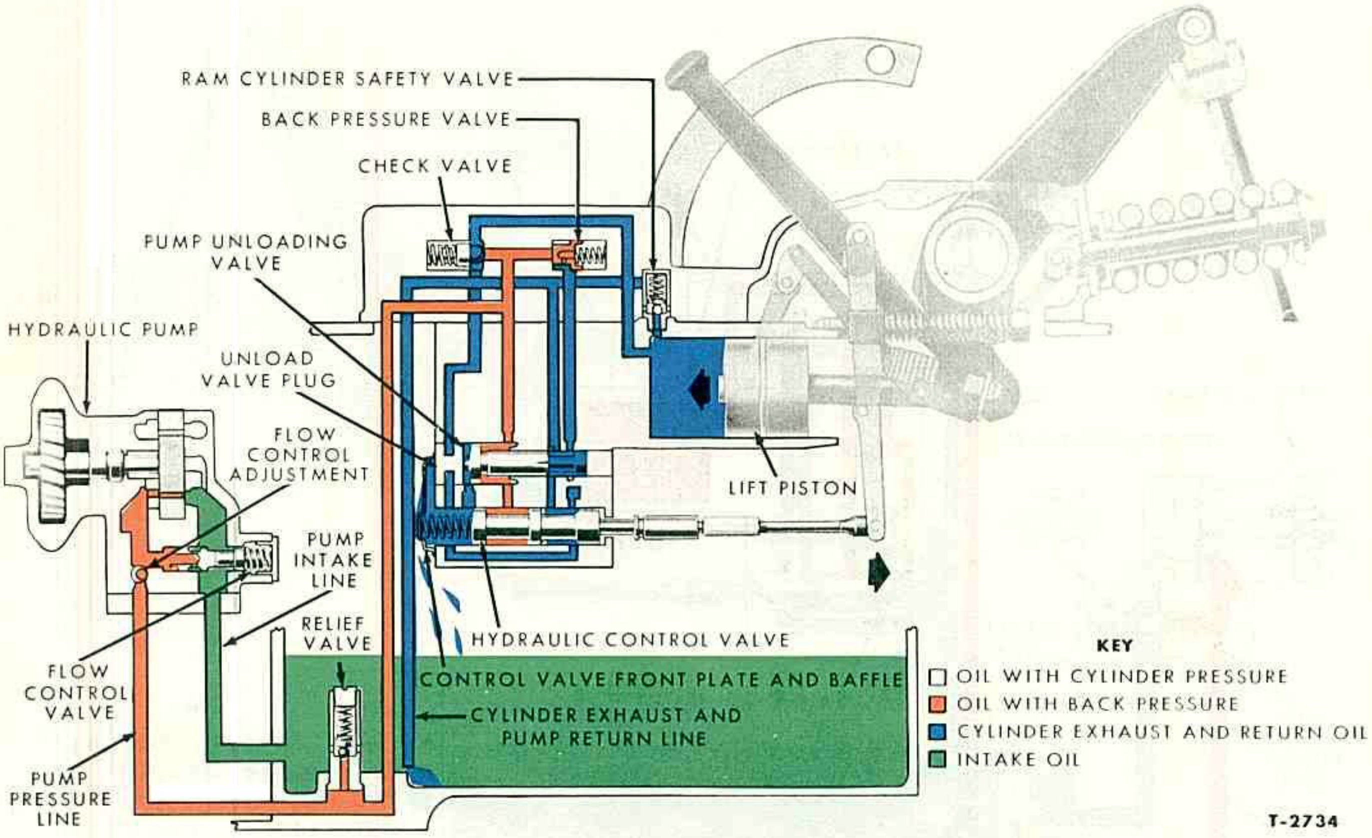

Figure 4—Oil Flow—Lowering Position

loads resulting from carrying heavy implements over rough terrain with the control valve in the neutral position.

Control Valve: The control valve, Figure 2, directs the flow of oil for raising or lowering an implement. When in draft control, force applied to the control spring actuates the valve. When in position control, the cam on the lift arm actuates the valve.

Unloading Valve: The unloading valve, Figure 2, is hydraulically operated. The position of this valve determines whether the oil from the pump is directed to the lift cylinder to raise an implement or is bypassed to the reservoir.

Back Pressure Valve: The back pressure valve, Figure 2, is to maintain a constant pressure of low magnitude in the system for positioning the unloading valve.

Increased tractor hydraulic system sensitivity and durability which are desired in certain implement applications can now be obtained by using new special control valves, control valve bushings and an externally mounted hydraulic system filter which are available for service only. The control valve, control valve bushings and filter can be installed on all Ford Tractors with the current type hydraulic system.

Increased sensitivity is provided by the new control valve and bushing in the following manner. The lift land of the control valve is chamfered so that less reaction on the top link is required to move the control valve forward to a lift position. This, in effect, means that corrections required by changing draft conditions will be of a smaller magnitude. A smaller diameter hole, on both the inlet and outlet sides of the unloading valve, means that as oil is introduced to the valve, the pressure build-up in the system will be at a slower rate. Thus, the smaller magnitude corrections brought about by the new control valve will be slower and smoother.

A slot incorporated in the bushing in place of the drop orifice, and a new orifice in the discharge line increases the rate of drop of an implement. The rate of drop is faster because as soon as the draft reaction to the top link decreases and the control valve moves to a lowering position, the entire area of the drop orifice is exposed.

It is recommended that whenever the new control valve and control valve bushing are installed in a tractor that the hydraulic filter also be installed. The filter also can be installed on tractors where old style hydraulic parts are used and where increased sensitivity, provided by the new hydraulic parts, is not required.

C. Hydraulic Control System Oil Flow

Neutral Position: Since the pump is continuously delivering oil to the hydraulic system whenever the engine is operating, the oil will be returned to the reservoir as follows: With the control valve in neutral, oil is pumped into the pressure line which incorporates the combination back pressure and check valve seat passage. A drilled hole and annular ring makes this section a common passage to the check and back pressure valves. The check and back pressure valves are closed, therefore, oil will flow down the passage leading to the unloading valve chamber. It will continue to flow around the annular ring in the forward bushing and apply pressure against the rear face of the unloading valve to hold it in the unload position. The oil will continue to flow down around the annular ring in the control valve bushing to fill the annular ring and trap the oil.

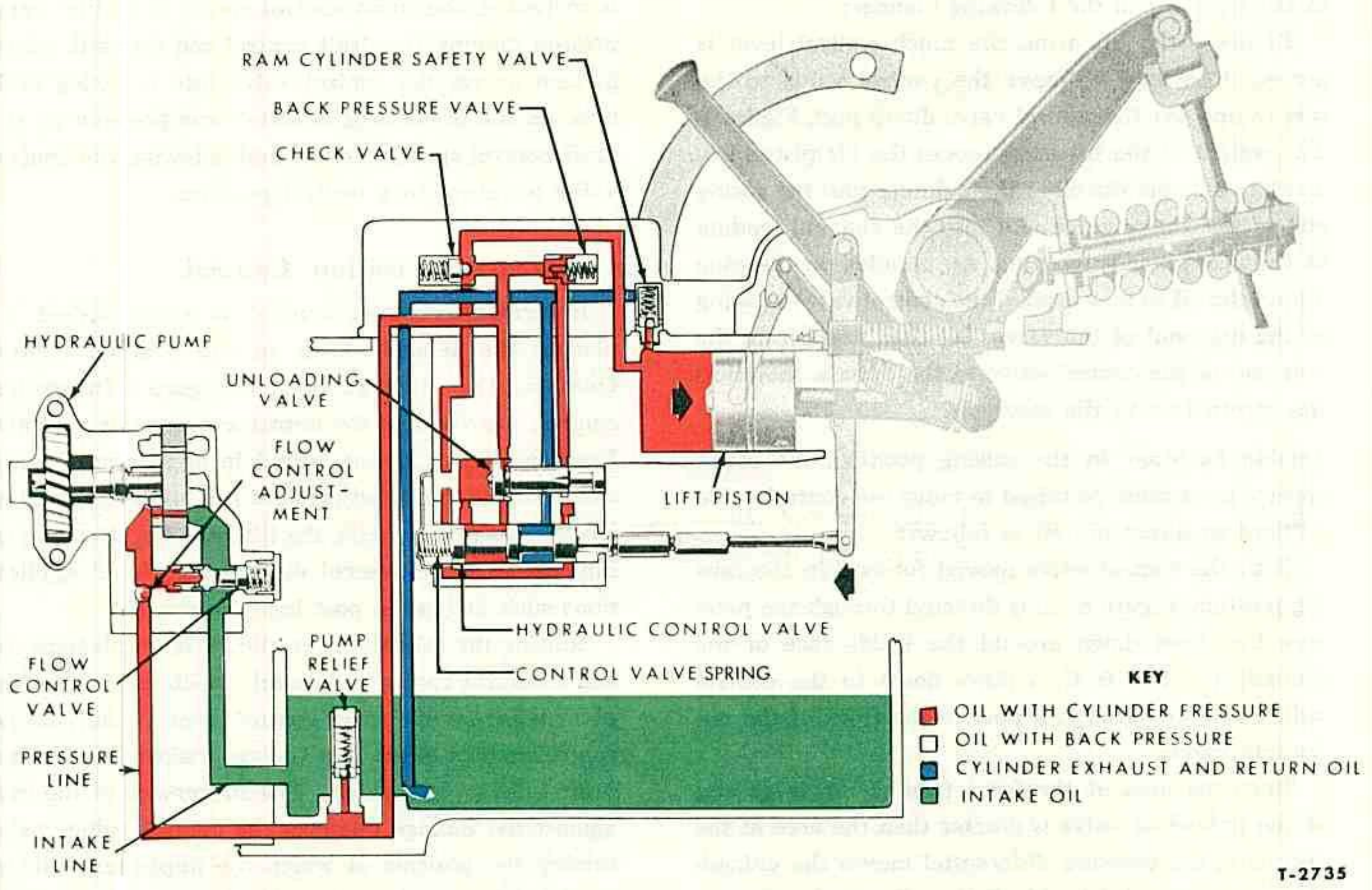

Figure 5—Oil Flow—Raise Position

With the unloading valve being in the forward position, pressure will build up in this passage until the back pressure valve, which offers less resistance than the check valve, is forced off its seat. The oil will then flow down this passage and make a "U" turn at the unloading valve. The "U" turn is made due to the control valve land ports and annular rings.

The annular ring provided in the check and the back pressure seat provides the oil return passage back to the reservoir.

Moving the unloading valve forward, opened up the "U" turn for the return oil. Any oil in front of the unloading valve would be forced out through the passage in front of the control valve through the spring area and out through a port located in the front end plate down into the reservoir.

Lowering Position: In the lowering position, oil is returned to the reservoir in the same manner as detailed in the neutral position. In addition, oil is exhausted from the lift cylinder to lower the arms and returned to the reservoir in the following manner:

To lower the lift arms, the touch control lever is moved downward to move the control valve to the rear to uncover the control valve dump port, Figure 4. The weight of the lift arms moves the lift piston forward, to exhaust the oil in the cylinder past the spring end of the check valve and into the channel leading to the unloading valve plug. An annulus on the plug allows the oil to flow around the control valve bushing to the rear end of the valve. Oil then flows from the rear end of the control valve to the bypass, then into the return line to the reservoir.

Raising Position: In the raising position, the touch control lever must be raised to move the control valve forward to direct the oil as follows:

With the control valve moved forward in the raising position, Figure 5, oil is directed through the pressure line then down around the inside face of the unloading valve. It then flows down to the control valve then up through a port to the front of the unloading valve.

Since the area at the front face of the large end of the unloading valve is greater than the area at the rear face, the pressure differential moves the unloading valve rearward to block the oil return passages. Pressure is then built up in excess of 115 psi to force the check valve off it's seat. Oil then enters the lift cylinder to move the piston to the rear and raise the lift arms.

D. Draft Control

Draft control is accomplished by placing the selector lever in the draft control (downward) position as shown in Figure 1. When the selector lever is in draft control, the position control rod spring is compressed. This places the pivot point of the hand control lever at the draft control swivel, which is held in position by the draft control spring.

When the touch control lever, Figure 1, is placed in the raised position, the hand control lever pivots at the draft control swivel moving the control valve forward into the raising position. Raising is stopped when the ram cylinder piston moves out far enough to contact the pin on the hand control lever, moving the control valve into the neutral position.

Assume that a field is being plowed at a 6″ depth. When the draft load from the implement being used is increased, the main control spring is further compressed moving the draft control rod forward, which in turn moves the control valve into a raising position. As the implement is raised, compression on the draft control spring is decreased, allowing the control valve to return to a neutral position.

E. Implement Position Control

Implement position control is accomplished by placing the selector lever in the position control (horizontal) position as shown in Figure 2. In position control, the depth of the implement remains constant. Position control is very useful in applications where small increments of adjustment are necessary, such as when raising or lowering the lift links for attaching an implement, or to control working depths of applications such as blades, post hole diggers, etc.

Raising the selector lever allows the implement position control spring to expand, which establishes the pivot point for the hand control lever at the position control rod. In effect, this linkage makes the constant draft linkage inoperative. The movement of the cam against the linkage operates the control valve, maintaining the position at which the implement will be carried. The position of the implement will be determined by the position of the touch control lever on the quadrant.

PART FOUR

HYDRAULIC SYSTEM

Chapter

II

Adjustments, Component Parts, Trouble Shooting and Special Tools

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4 Lift Cylinder 394
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6 Pump Relief Valve and Oil Tubes 408
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1. HYDRAULIC CONTROL ADJUSTMENT

Before making draft and implement position control adjustments, adjust the main control spring. To make this adjustment, screw the yoke, Figure 1, clockwise or counterclockwise as much as required to obtain a preset compression on the main spring. This compression should be tight enough so that you are just able to rotate the spring with fingers and thumb of one hand. ALWAYS make the draft control adjustment first.

A. Constant Draft Control Adjustment

1. Attach Lift Arm Positioning Gauge NCA-503-B to the cover as shown in Figure 1. Install the locating pin through the lift arm.
2. Move the selector lever from draft control to position control a few times to make sure there is no binding in the linkage.
3. Place the selector lever in draft control position as shown in Figure 1.
4. Raise the touch control lever until it contacts the cam stop. Make certain the lobe on the cam stop is in the maximum forward position (toward the bottom as shown in Figure 1). If the cam stop needs repositioning, be sure the retaining nut is securely tightened after adjustment.
5. Loosen the control valve turnbuckle lock nut and adjust the turnbuckle as required until the draft end of Gauge NCA-502, Figure 1, can just be

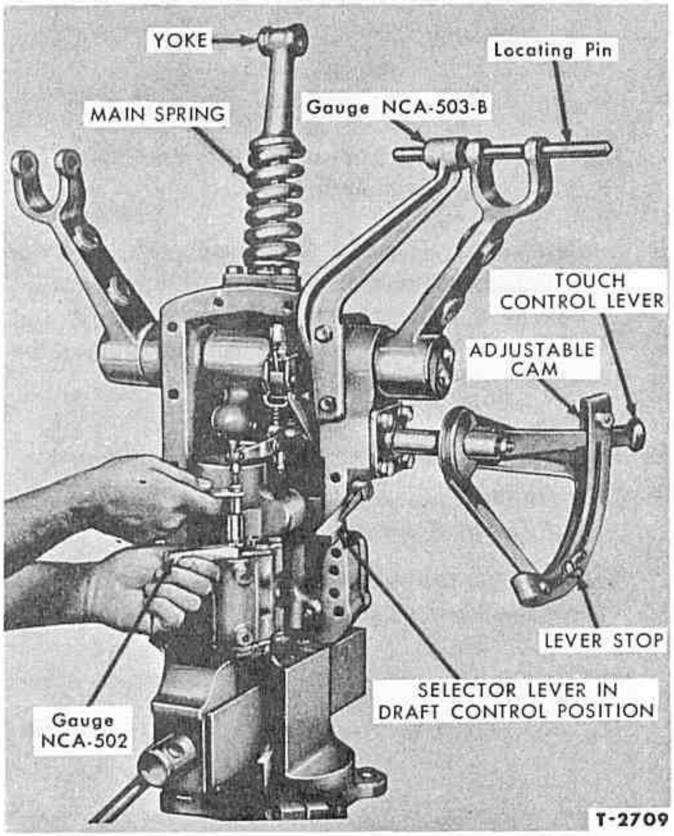


Figure 1—Adjusting Control Valve in Constant Draft Position

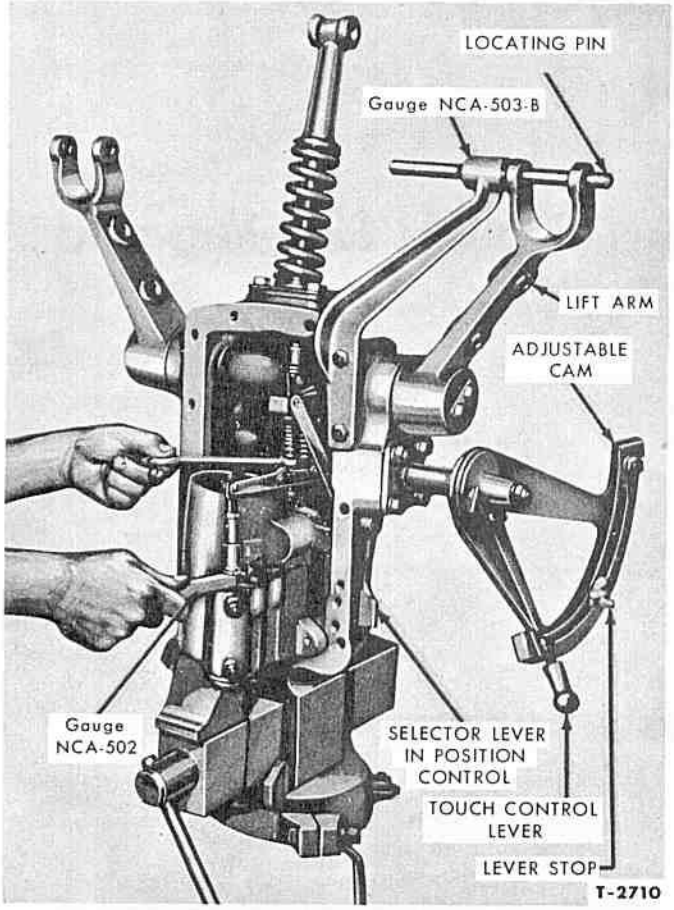


Figure 2—Adjusting Control Valve in Implement Position Control

inserted between the machined surface of the cylinder and the control valve. After adjustment, tighten the turnbuckle lock nut securely, and recheck with the gauge before attempting the adjustment of implement position control.

B. Implement Position Control Adjustment

1. Place the control selector lever in position control (parallel with the lift cover).
2. Move the touch control lever to the bottom of the quadrant against the stop.

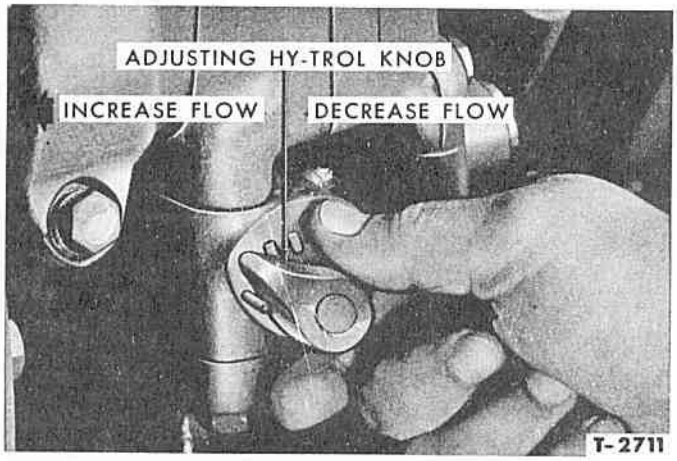


Figure 3—Adjusting Hydraulic Pump Oil Flow in Vane Type Pumps

3. Check the clearance between the control valve land and the machined surface of the cylinder using the position end of Gauge NCA-502, Figure 2. The gauge should be a snug slip fit between the control valve and cylinder. Adjustment is made by holding the lock nut and turning the position control rod, as required to get the proper tool fit. After adjusting, recheck with the gauge.

C. Hydraulic Pump Flow Control Adjustment

The Flow Control Valve, incorporated only in vane type hydraulic pumps, controls the speed at which implements may be raised. Turning the valve counterclockwise, increases the flow of oil to the lift cylinder and turning the valve clockwise decreases the flow of oil, Figure 3.

NOTE: ***Piston type pumps are not provided with a flow control valve and require no adjustment.***

The valve may be set at any one of five positions, depending upon the type of implement being used. The slower speeds should be used for plowing and similar work, and the faster speeds are recommended for use with auxiliary equipment such as loaders and remote cylinders.

2. LEVELING BOX

The leveling box, located on the top of the right-hand lift link is provided to give ease in attaching implements to the three point hook-up. The leveling box in addition, provides for ease of implement adjustment during field operation.

A. Removal

1. Remove the leveling box assembly from the tractor by removing the check chain eyelet which retains the check chain and leveling box assembly to the lower link.

2. Disassemble the knuckle from the gear box by removing the cotter pin and clevis pin.
3. Turn the crank until the leveling rod fork is separated from the leveling gear shaft.
4. Remove the expansion plug at the top of the gear box (drill and use punch if necessary), then drive the pin from the operating crank and withdraw the crank and leveling crank gear.
5. Drive the plug and leveling gear shaft from the gear housing, taking care not to damage the threads.
6. Remove the bearing from the housing with a punch and hammer.
7. Replace the leveling gear shaft and leveling gear if they show signs of wear.
8. Replace all parts that show signs of wear or of being bent.

B. Installation

1. Install a new bearing on the leveling gear shaft and push the shaft into operating position in the gear box housing.
2. Position the leveling crank gear into the box, then push the leveling crank through the gear. Install the retaining rivet. Make certain the gears rotate freely before upsetting the rivet in the end of the operating shaft.
3. Install the expansion plug in the end of the housing.
4. Screw the leveling gear shaft into the leveling fork.
5. Assemble the leveling box assembly to the tractor. Secure the knuckle to the leveling gear box with the pin and cotter pin.
6. Install the leveling rod fork and check chain to lower link eyelet and tighten the retaining nut.

3. LIFT COVER

The hydraulic lift cover assembly consists of the cover, lift arms, and the control linkage.

Always clean all dirt from the lift cover and vicinity before removing it. Even minute particles of dirt entering the system will quickly wear the pump and valve mechanisms, resulting in premature failure, or leakage.

A. Removal

1. Remove the tractor seat and place the touch control lever in the lowering position.
2. Disconnect the lift arms from the lift links by removing the cotter pins and clevis pins.
3. Remove the cotter pin from the draft control spring yoke and rocker and remove the clevis pin.
4. After the cover attaching bolts are removed, lift the cover from the center housing and place it in a soft jawed vise with the yoke pointing upward, and with the ram cylinder and valve mechanism facing outward for easy access while servicing.

B. Disassembly

1. Remove the check valve plug from the lift cover.
2. Remove the check valve pilot with "O" ring, spring, pilot and ball from the lift cover. Discard the "O" ring from the check valve pilot.
3. Screw the pilot of Remover and Replacer NCA-997 into the check valve seat and remove the seat, using wrenches as shown in Figure 4.
4. Remove the back pressure valve and spring from the lift cover.
5. Remove the accessory plate from the lift cover and discard the "O" rings. Location and part number of the "O" rings are shown in Figure 5.
6. Remove the main control spring from the cover, Figure 6, by turning the yoke counterclockwise to unscrew it from the draft control spring plunger.
7. Remove the main control spring seat, seat support, felt and plate from the lift cover.
8. Disconnect the control valve linkage. Remove the cap screws that secure the lift cylinder to the lift cover (one of these is recessed in the lift cover) and remove the lift cylinder assembly straight out from the lift cover to avoid damage to the safety valve. Location and part numbers of cylinder to cover "O" rings are shown in the insert, Figure 5. Discard the "O" rings.

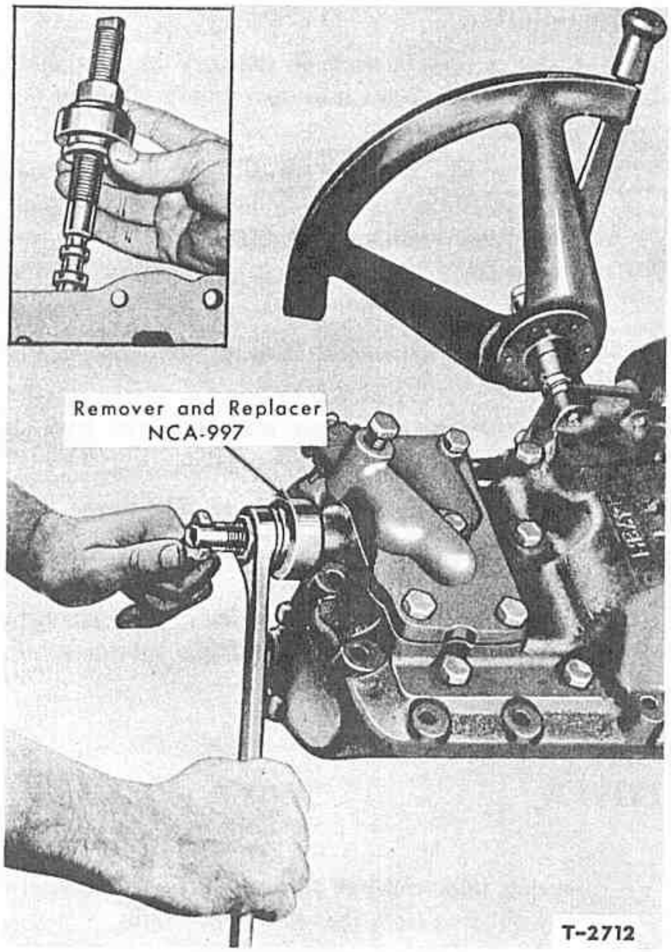


Figure 4—Removing Check Valve Seat

9. Remove the ram cylinder piston rod from the ram arm, by removing the cotter pin and retainer pin.
10. Remove the nut and washer that retain the draft control bushing on the draft control link rod.
11. Remove the nut, spring, and washer, then remove the touch control lever, Woodruff key, friction plate and cork disc from the hydraulic lift control lever shaft.
12. Remove the cap screws securing the quadrant assembly to the lift cover, and slide the quadrant assembly from the lift control lever shaft.
13. Remove the cotter pin, nut, and washer securing the hand control lever assembly to the lift control lever shaft, and slide the hand control lever and swivel assembly forward off the draft control bushing. Slide the hand control lever from the lift control lever shaft and remove it from the lift cover.
14. Remove the draft control bushing and draft control spring from the draft control link rod.
15. Remove the cotter pin and washer that retain the selector control link to the selector control arm, then remove the position control assembly and lift control lever shaft from the lift cover.
16. Straighten the lock washer tabs, remove the retaining cap screws and washers and remove the right and left lift arms from the main lift shaft, Figure 7.

NOTE: ***Late models have only one cap screw in each arm.***

17. Withdraw the hydraulic lift shaft from the cover.
18. Remove the ram arm and the lift shaft bushings from the lift cover.
19. Remove the draft control link and draft control spring plunger assembly from the lift cover.
20. Remove the pin which secures the selector lever to the selector control arm. Remove the selector

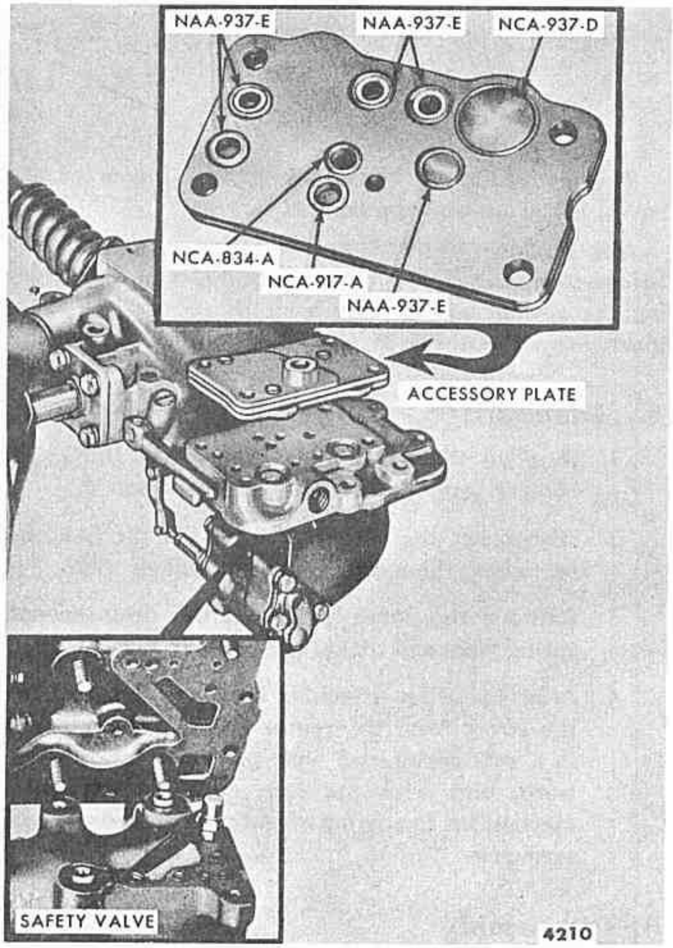


Figure 5—Accessory Plate and Cylinder Showing Location of "O" Rings

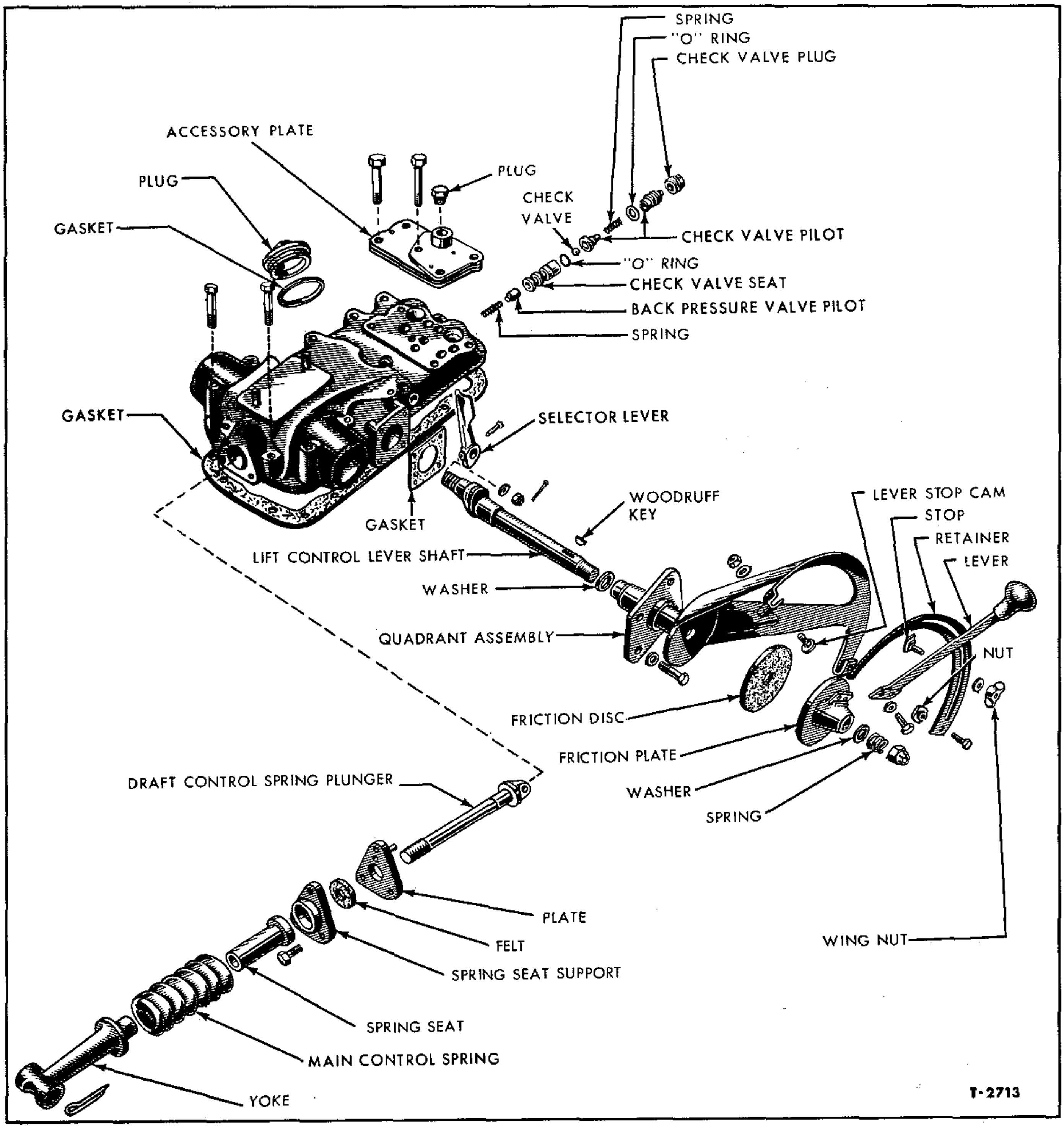


Figure 6—Hydraulic Lift Cover—Disassembled

control arm detent spring retaining plug, detent spring and detent ball, then remove the selector control arm and "O" ring.

21. Remove the pin retaining the draft control link to the draft control spring plunger.
22. Remove the snap ring securing the swivel to the hand control lever and remove the swivel.
23. Remove the pin securing the selector control link to the position control arm.
24. Remove the pin securing the position control cam to the position control arm.
25. Remove the lock nut retaining the locking plate, position control rod and position control spring to the position control arm and disassemble.

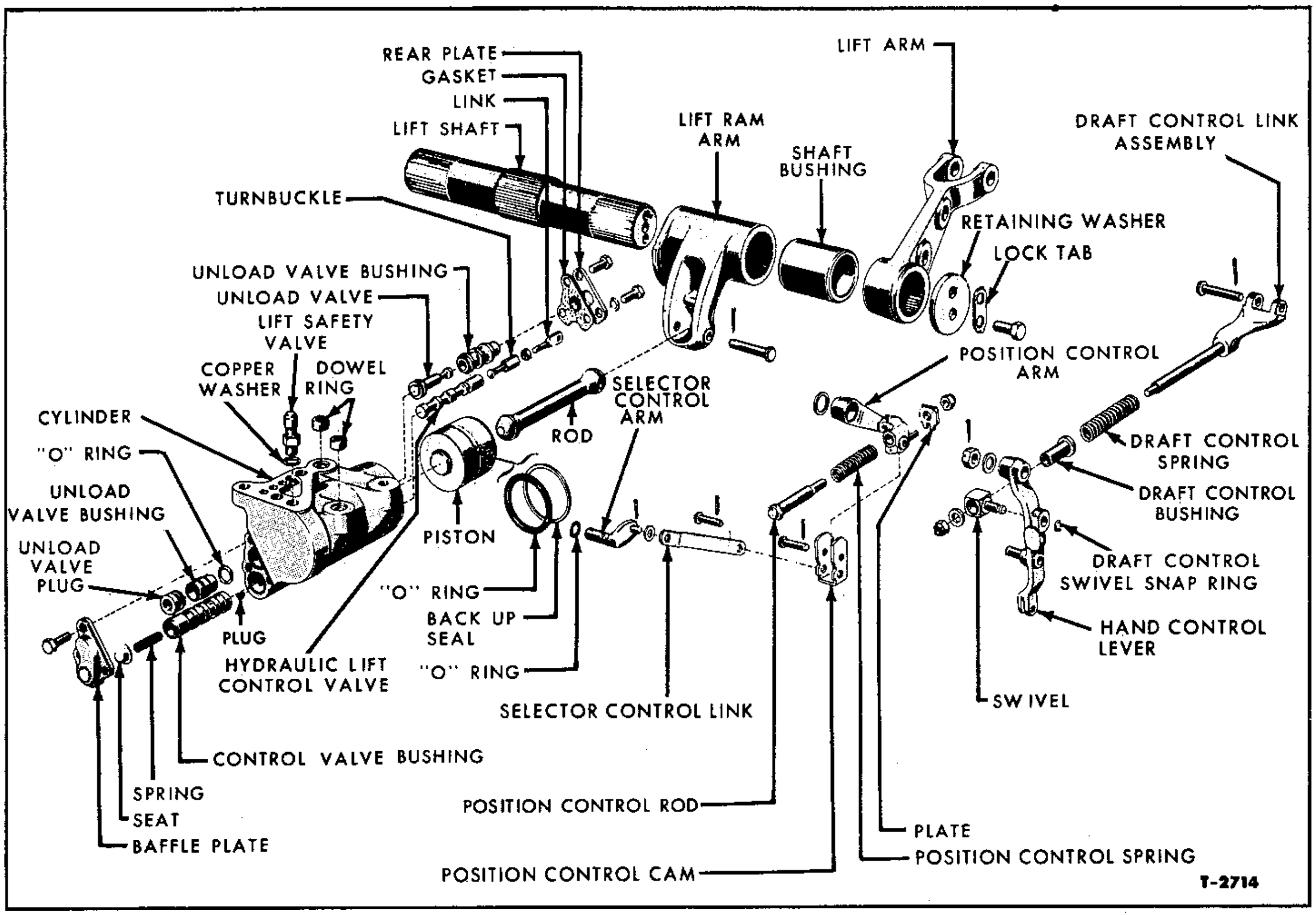


Figure 7—Lift Cylinder Assembly—Disassembled

C. Inspection

1. Replace the hydraulic lift cover if cracks are found. Replace the lift shaft if it is worn or if the bearing surfaces are scored. Replace the hydraulic lift shaft bushings if side movement is noticeable or if the inside diameter is excessively worn.
2. Check the control linkage for excessive wear or bends.
3. Replace the draft control bushing and swivel if they are worn.
4. Replace the position control arm if it is worn.
5. Discard any springs that show evidence of rust or corrosion.

D. Assembly

The lift cover is shown disassembled in Figure 6. The lift cylinder assembly and the linkage and lift

1. Install the lift cover in a vise with the check valve hole in a vertical position facing upward.
2. Install the back pressure spring and valve in the lift cover (lubricate the valve before installing).
3. Remove the thrust washer and bearing from Remover and Replacer NCA-997. Install the check valve seat in the lift cover, as shown in Figure 8.
4. Install a new "O" ring on the check valve pilot, and install the check valve ball, pilot spring and check valve pilot with "O" ring in the lift cover, Figure 6.
5. Install the check valve plug in the lift cover and tighten it to 45-55 ft. lbs. torque.
6. Install a new "O" ring in the recess on the lift cover and install the selector control arm through the lift cover and "O" ring, then install the selector lever and retaining pin to the selector control

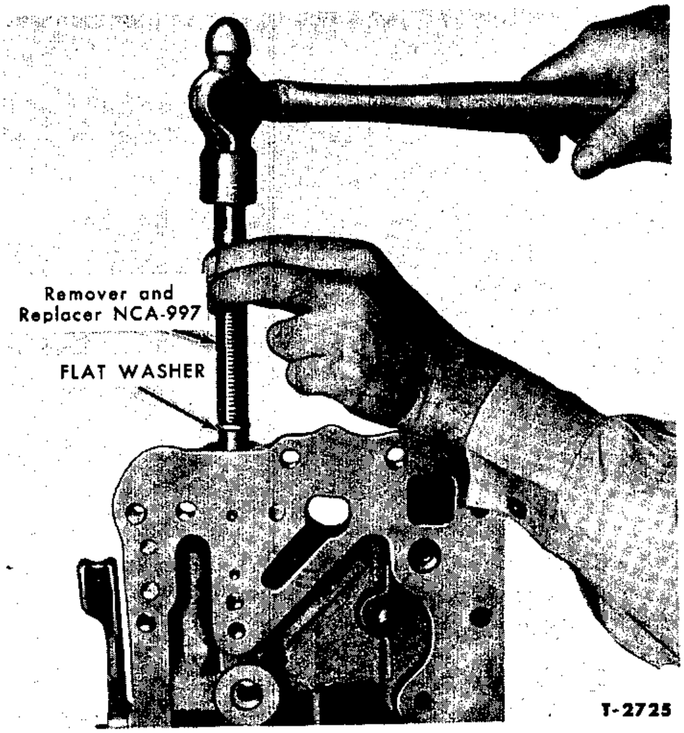


Figure 8—Installing Check Valve Seat

7. Attach the draft control swivel, bushing and spring to the draft control link assembly with the flat washer and lock nut. Be sure the nut is pulled up tight against the flat washer and shoulder on the link rod, Figure 7.
8. Attach the draft control plunger to the draft control lift with the clevis pin and cotter pin.
9. Assemble the position control lift arm assembly. Assemble the spring to the rod, the rod and the spring to the position control arm assembly, and locking plate to the rod with one lock nut. Secure the position control cam to the position control arm with a clevis pin and cotter pin.
10. Attach the selector control link to the position control arm with the clevis pin and cotter pin, Figure 7.
11. Install the draft control link and draft control spring plunger assembly in the lift cover.
12. Position the ram arm in the lift cover and insert the lift shaft through the ram arm. Install the bushings over each end of the lift shaft and position them flush with the housing.
13. Install the lift arms on the lift shaft. Secure them in position by installing the washer, lock plate and cap screws on each one. Bend the ends of the plate over the cap screws to lock them in position. Make certain the arms operate freely after assembly.
14. Position the control lever assembly and the control lever shaft into the lift cover, and install the selector control link to the selector control arm. Install the retaining washer and cotter pin, Figure 6.
15. Install the draft control spring and draft control bushing on the draft control link, Figure 7.
16. Install the hand control lever assembly on the lift control lever shaft, then slide the swivel over the draft control bushing on the draft control link. Install the washer, nut, and cotter pin which retain the hand control lever to the control shaft, then loosely replace the washer and nut which retain the draft control bushing on the draft control rod, Figure 7.
17. Position a new gasket on the quadrant assembly and secure the quadrant assembly to the housing with cap screws. Position a new friction disc next to the quadrant, then install the Woodruff key and friction plate. Place the flat washer and spring next to the hub and install the retaining nut.
18. Install the touch control lever to the friction plate with cap screws.
19. Tighten the draft control bushing retaining nut.
20. Install the piston rod and secure it to the ram arm with a clevis pin and cotter pin, Figure 7.
21. Install new "O" rings in the cylinder assembly and install the cylinder assembly in the hydraulic lift cover. Tighten the bolts to 60-80 ft. lbs. torque. Be sure the longest bolt is placed through the machined hole in the lift cover, Figure 6.
22. Install the control valve turnbuckle and secure it with a clevis pin and cotter pin, Figure 7.
23. Install the selector arm detent ball, spring and seat in the lift cover.
24. Place the cover support plate seal, spring seat, and cover plate over the plunger and secure the cover plate to the housing with bolts. Position the main control spring over the spring seat and secure the yoke to the plunger rod by turning it clockwise.

NOTE: ***Apply heavy grease (equivalent to Ford Spec. M-4664) to the plunger prior to assembly.***

25. Install new "O" rings in the accessory plate. Position the accessory plate on the hydraulic lift cover. Position the $\frac{5}{16}$ inch bolt in the center of the accessory plate and tighten it to 12-15 ft. lbs. torque, then install the two remaining bolts and tighten them to 45-65 ft. lbs. torque, Figure 6.

E. Installation

1. Clean the mating surfaces of the cover and center housing and lay a new gasket in position on the center housing.
2. Set the lift cover into position over the gasket and install the bolts. Tighten all bolts to 45-65 ft. lbs. torque.
3. Attach the lift control yoke to the rocker arm with a clevis pin and cotter pin. Connect the lift arms to the leveling rods.
4. Install the tractor seat.

4. LIFT CYLINDER

The lift cylinder assembly is composed of the ram cylinder piston, and oil valves (except check valve and pump relief valve) and bushings that control operation of the hydraulic system, and the cylinder housing.

A. Lift Cylinder Removal

1. With the lift cover mounted in a vise, remove the accessory plate to gain access to one lift cylinder retaining bolt. Discard the accessory plate "O" rings.
2. Remove the turnbuckle assembly from the lift control lever and control valve by removing the cotter pin and clevis pin. Remove the safety valve by turning it counterclockwise.
3. Separate the lift cylinder from the lift cover by removing the cap screws, then install the cylinder assembly in a vise. Discard the "O" rings.

B. Disassembly

1. Remove the front baffle plate, gasket and control valve spring from the lift cylinder.
2. Remove the rear plate and gasket from the cylinder assembly by removing the cap screws. Remove the control valve.
3. Remove the unloading valve plug from the cylinder assembly, using a slide hammer as shown in Figure 9. Remove the unloading valve and discard the "O" rings.
4. Remove the front and rear unloading valve bushings with Remover and Replacer, N-508-A, Figure 10.
5. Remove the control valve bushing with Remover and Replacer, N-508-A, Figure 11. If the lift cylinder is equipped with a special control valve to obtain slower hydraulic action, remove the plug and restrictor from the lift cylinder, Figure 12.
6. Remove the piston from the cylinder by applying air pressure through the safety valve hole while holding your finger over the exhaust hole.

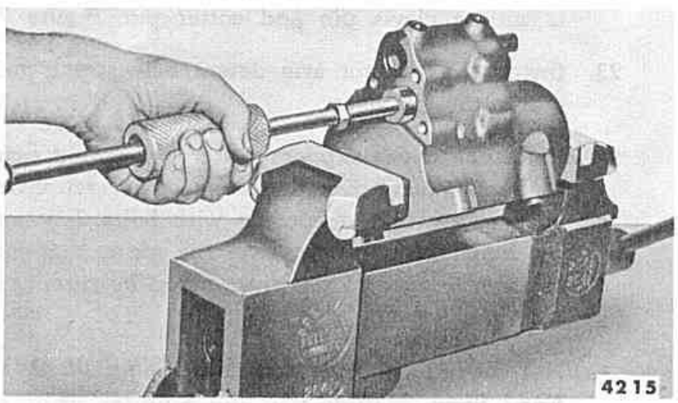


Figure 9—Removing Unloading Valve Plug

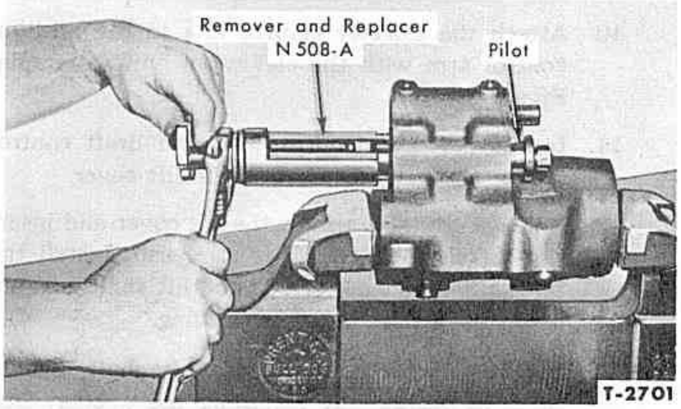


Figure 10—Removing Front and Rear Unloading Valve Bushing

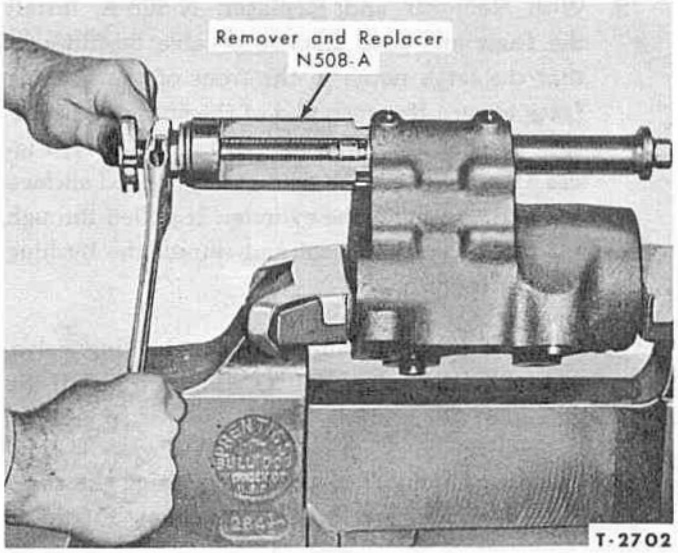


Figure 11—Removing Control Valve Bushing

CAUTION: ***Do not use excessive air pressure as the piston may fly out and cause injury or damage.***

7. Remove the "O" rings and back-up seal from the piston and discard them.

8. Clean all parts in solvent. Blow them dry with air. Inspect for nicks, burrs, scuffing or other signs of wear. Replace any parts found defective.

C. Assembly

1. Soak the back-up seal in warm water for 2 minutes to prevent its breaking when stretched, then fit it over a piston ring compression tool. Install it on the piston, Figure 13, so that the roughened side of the seal mates with the "O" ring. The back-up seal must be placed toward the open end of the piston.

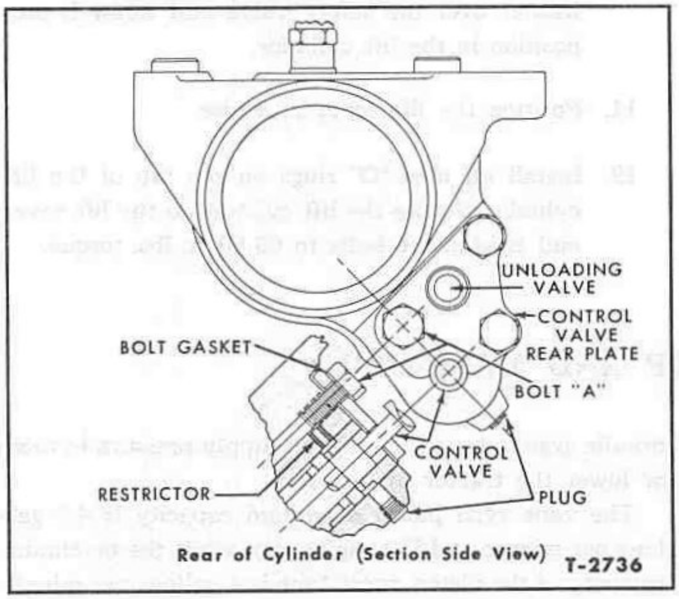


Figure 12—Rectrictor—Installed

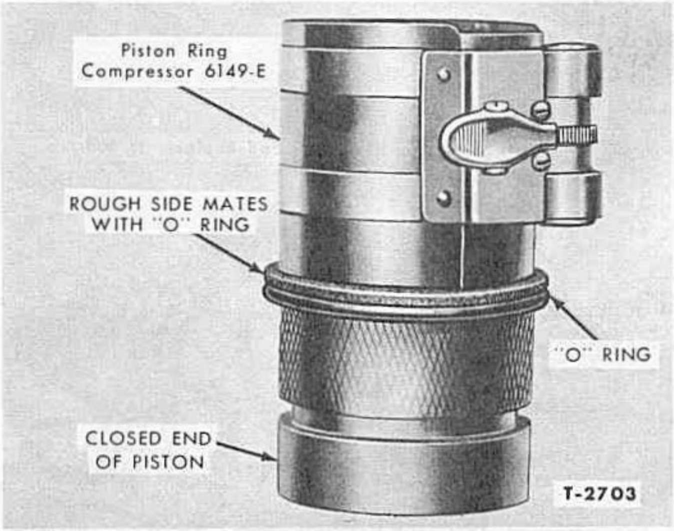


Figure 13—Installing Piston Back-up Seal and "O" Ring

2. Lubricate the "O" Ring and seal and install the compressing tool over the piston seals. Lubricate the cylinder wall, then install the piston by pushing it into the cylinder as the compressing tool is removed.

Cylinders with Modified Control Valve and Bushing -Slow Acting:

3. Install the cylinder flow restricter in the drilled passage which joins the control valve bushing bore to the drilled passage in which the hex head bolt "A" is installed, Figure 12. This is accomplished by removing the Allen head plug at the plate end of the cylinder and pressing the

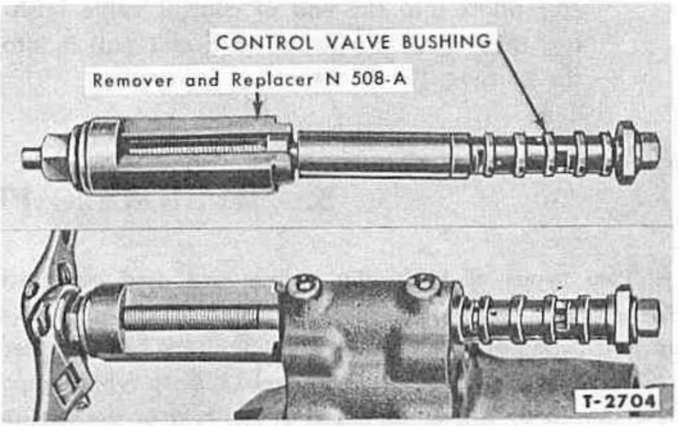


Figure 14—Installing Control Valve Bushing

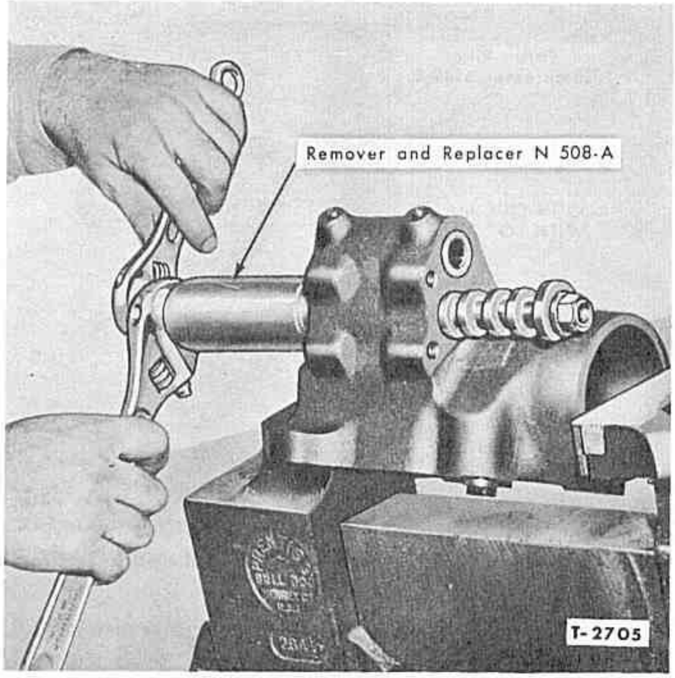


Figure 15—Installing Front and Rear Unloading Valve Bushings

restricter into the passage using a flat end rod or punch.

IMPORTANT: *Care should be exercised not to distort the orifice opening of the restrictor or press the part in too far to where interference with the threaded portion of the hex head bolt results.*

4. Secure the cylinder housing in a vise, then install the pilot of Remover and Replacer, N-508-A, in the bushing bore. Install the puller shaft through the pilot and bushing, making certain that the large land of the bushing leads into the bore. Install the washer so that the small diameter pilots into the end of control valve bushing, then lubricate the bushing and pull it into the housing, Figure 14.

5. With Remover and Replacer, N-508-A, install the front and rear unloading valve bushings so that the large notch in the front of the bushing faces toward the open end of the cylinder. Lubricate the bushing, then pull it into the bore, Figure 15, until it is flush with the machined surface at the open end of the cylinder. If pulled through too far, reverse the tool and retract the bushing until it is flush.

6. Install a new "O" ring on the unloading valve. Lubricate the valve and "O" ring and install the valve in the bushing.

7. Install the unloading valve plug, using the same slide hammer tool used in removal, Figure 9.

   IMPORTANT: *The threaded end of the plug must always face toward the front of the cylinder.*

8. Position a new gasket on the front baffle plate (closed end of cylinder). Install the control valve spring in the bore, hold the plate against the spring and secure it by installing the retaining cap screws.

9. Lubricate the control valve and slide it into the bushing.

10. Secure a new gasket and rear plate to the cylinder assembly with bolts and a new special steel washer as shown in Figure 12. Install the copper washer over the safety valve and screw it into position in the lift cylinder.

11. Position the lift cover in a vise.

12. Install all new "O" rings on the top of the lift cylinder. Secure the lift cylinder to the lift cover and tighten the bolts to 60-80 ft. lbs. torque.

5. HYDRAULIC PUMP AND MANIFOLD

Two types of hydraulic pumps are used on Ford Tractors, the vane type and the piston type pump. The piston type pump may be equipped with a ball or roller bearing as shown in Figures 17 and 18. Both type pumps are driven by a gear mounted at the rear of the engine camshaft. The pump is connected to the tractor hydraulic system by a manifold to supply pressure to raise or lower the tractor lift arms.

The vane type pump maximum capacity is 4.7 gallons per minute at 1650 engine rpm while the maximum capacity of the piston pump type is 4 gallons per minute at 2000 rpm. A sectional view of each type pump is

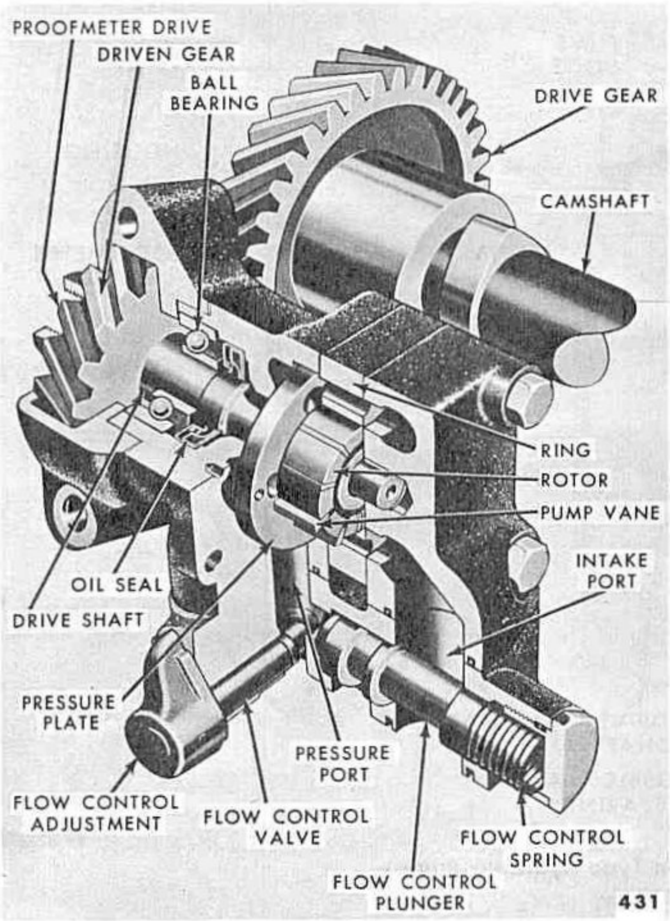


Figure 16—Vane Type Hydraulic Pump—Sectional View

shown in Figures 16, 17 and 18.

The pump and manifold can be removed as an assembly if desired, however, the pump to manifold attaching bolts should be loosened, before disconnecting the manifold from the transmission or pump from the engine.

A. Removal

1. Thoroughly clean dirt and grime from the pump and manifold prior to removal, as dirt entering the system will quickly wear the control valves and pump.
2. Disconnect the Proof-Meter cable at the pump.
3. Loosen the pump to engine mounting bolts to prevent stress on the manifold casting. Then, remove the manifold to pump retaining nuts. On the "Row Crop" or "Industrial" tractors, it will be necessary to remove the right side rail or remove and loosen the side rail retaining bolts as necessary to rotate the side rail on its axis, in order to gain access to the pump to manifold retaining nuts. Remove the pump to engine bolts and lift off the pump. Discard the gasket and "O" rings and place a clean cloth over the manifold to pump opening to prevent the entry of dirt.

B. Disassembly

Refer to the procedure pertaining to the specific hydraulic pump that is being disassembled.

Vane Type—Model 600, 700, 800, and 900 Tractors:

1. Clamp the pump in a vise equipped with soft jaws. Remove the two Allen head bolts and remove the flow control valve body, Figure 19. Discard the two "O" rings. Remove the Proof-Meter, bushing, gasket, and adapter from the housing.
2. Remove the bolt, lock washer and flat washer from the end of the drive gear shaft. Remove the two long bolts from the cover assembly and carefully separate the drive gear and drive gear housing from the pump body, leaving the pump shaft in the pump.
3. Remove the key and spacer from the shaft.
4. Remove the short bolts and remove the pump cover from the pump body. Discard the "O" rings.
5. Remove the cam ring from the pump body and discard the "O" ring.
6. Remove the rotor and vane assembly from the pump body.
7. Remove the vanes from the rotor.
8. Press the shaft and bearing assembly out of the pump body toward the rear. Remove the bearing from the shaft.
9. Remove the two dowels, pressure plate, "O" ring, and spring assembly from the pump body by tapping lightly against the inner surface below the oil seal.
10. Remove the "O" ring and spring from the pressure plate and discard the "O" ring.
11. Remove the oil seal from the pump body using Bearing Puller 956-2 and Slide Hammer 943-S, Figure 20.
12. Place the flow control valve body in a vise equipped with soft jaws.
13. Remove the plug from the end of the valve body, then remove the "O" ring, spring, and flow control valve plunger. Discard the "O" ring.
14. Drive the flow control adjusting valve retaining pin from the valve body.

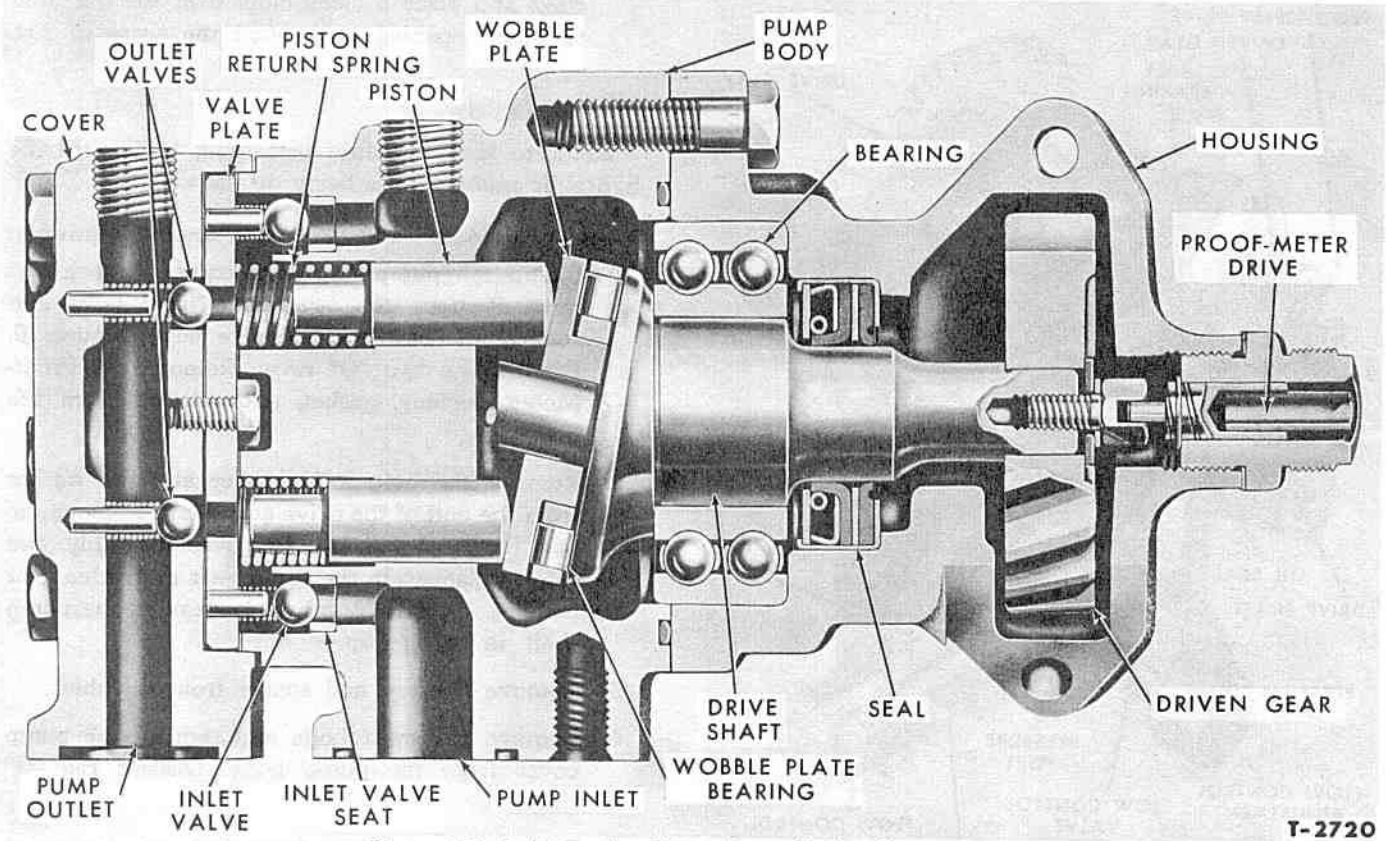


Figure 17—Ball Bearing Piston Type Hydraulic Pump—Sectional View

15. Remove the flow control knob, spring, and shaft as a unit and discard the "O" rings.
16. If it is necessary to replace the flow control knob, drive out the pin securing the knob to the shaft.

Vane Type—NAA:

1. Clamp the pump in a vise equipped with brass jaws.
2. Remove the Proof-Meter bushing, gasket and adapter from the mounting housing.
3. Remove the bolt, lock washer and flat washer that secures the gear to the end of the shaft, Figure 21.
4. Remove the two bolts that attach the mounting housing to the body. Separate the mounting housing and gear from the body with a soft hammer.
5. Remove the snap ring that secures the shaft in the body, Figure 21.
6. Pull the outer bearing and shaft from the body as an assembly.
7. Remove the four bolts and lock washers that attach the manifold to the body and cover. Separate the manifold from the body and cover.
8. Remove the four bolts that attach the cover to to the body. Carefully separate the cover from the body.
9. Slip the cam ring, pressure plate and rotor assembly from the dowels in the body, Figure 21.
10. Working from the cover side of the body, carefully drive the seal and inner bearing from the body with a punch.
11. Remove the rotor from the cam ring.

NOTE: ***Do not lose any of the vanes from the rotor***

12. Remove the flow control valve, plug, "O" ring, spring, and plunger from the cover, Figure 21.

Ball Bearing Piston Type Pump:

1. Remove the Proof-Meter Adapter Assembly.
2. Remove the bolts, lock washer and flat washer that attaches the gear to the end of the shaft, Figure 22.

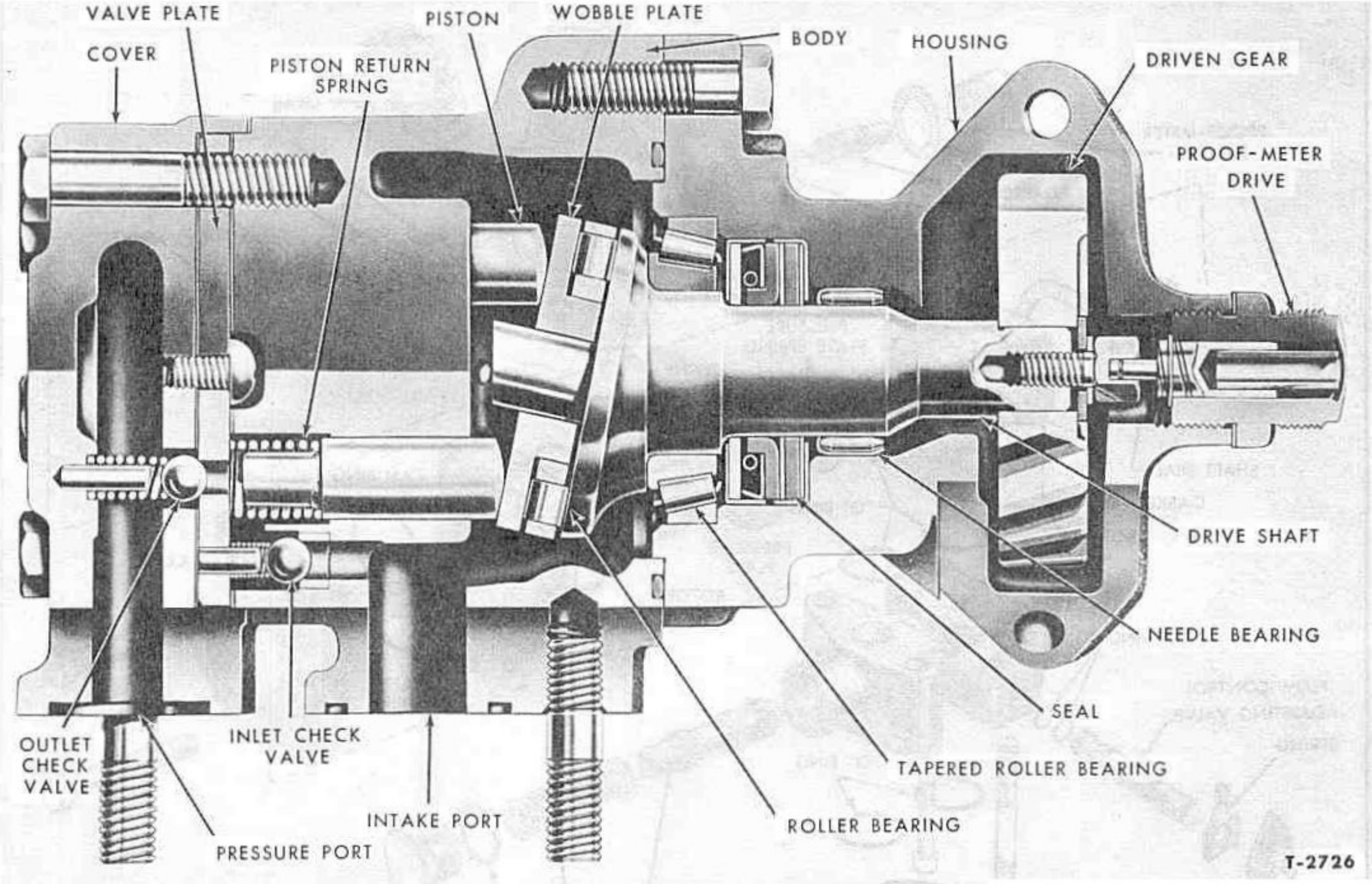


Figure 18—Tapered Roller Bearing Piston Type Hydraulic Pump—Sectional View

3. Remove the four bolts, that attach the housing to the body. With the pump in a horizontal position on the bench, separate the housing and shaft from the body. Lift the plate and bearing from the end of the shaft.
4. Drive the shaft and bearing from the housing with a long 3/16″ pin punch. Separate the gear from the housing.
5. Lift the six pistons and springs from the pump body.
6. Remove the six bolts that attach the cover to the body. Place the body on the bench in a vertical position, then, lift off the cover. Lift the six balls from the body. Remove the six springs from the plate.
7. Place the cover on the bench with the plate facing upward. Remove the plate attaching screw from the plate. Carefully work the plate out of the cover with two small punches. Remove six balls and springs from the cover.
8. If the shaft bearing is defective, remove it with a bearing puller as shown in Figure 23.
9. Remove the seal from the housing by using a long drift punch and driving against the seal through the Proof-Meter drive hole.
10. Remove the intake valve seats from the body with Valve Seat Remover, NCA-600-G as shown in Figure 24.

Tapered Roller Bearing Piston Type Pump:

1. Follow steps 1 through 7 under the disassembly procedure for the ball bearing pump. The tapered roller bearing pump is shown in Figure 25.
2. If the shaft bearing is defective, remove it with a bearing puller as shown in Figure 26.
3. Place the housing in a vise, as shown in Figure 27, and drive the seal down far enough to allow the jaws of Bearing Puller FT-943 to be placed under the bearing cup at "A", in Figure 28.
4. Connect Push Puller FT-938 to Bearing Puller FT-943 as shown in Figure 27 and remove the cup.

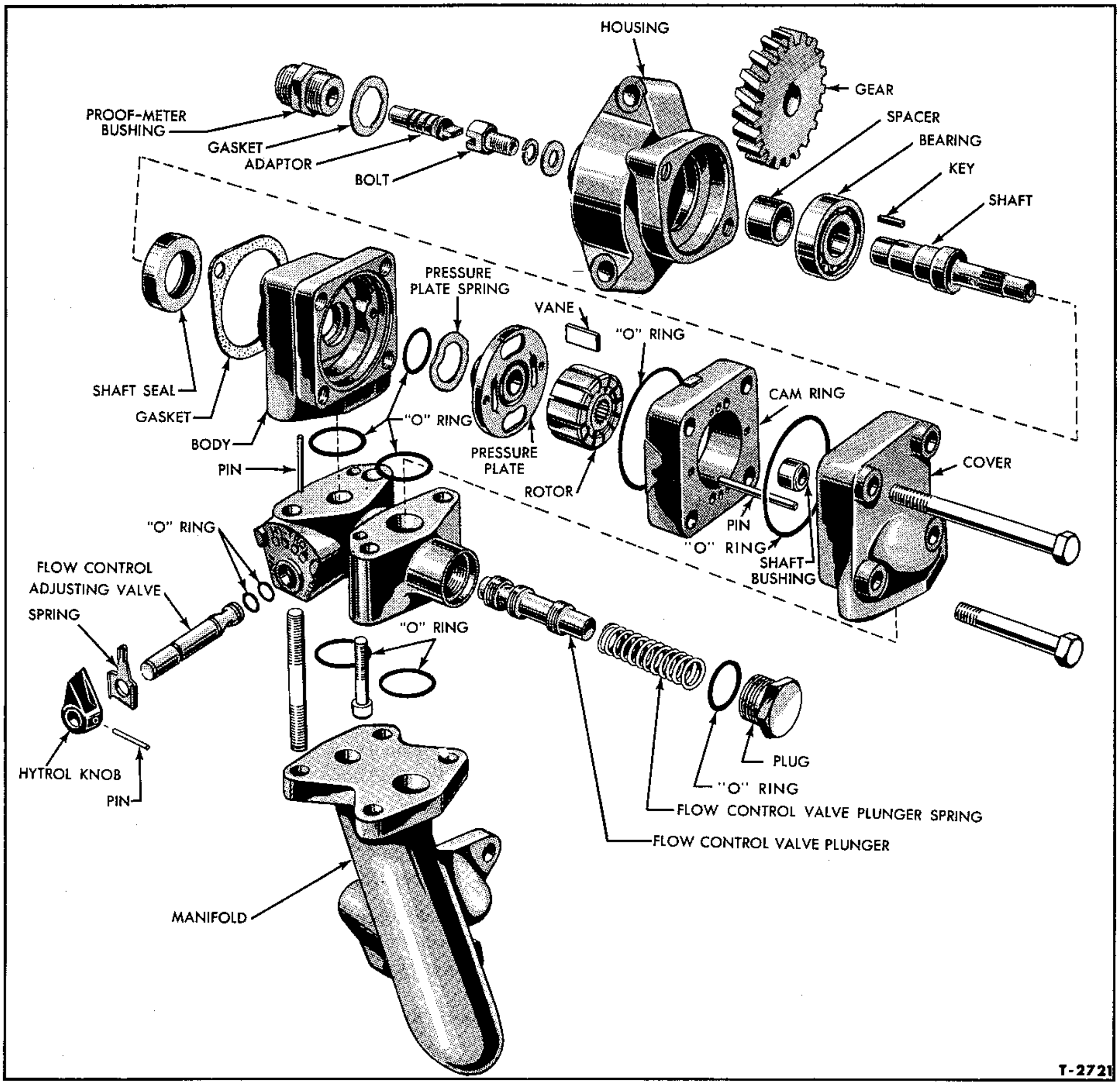


Figure 19—Vane Type Pump Disassembled—Model 600, 700, 800, and 900 Tractors

5. Remove the seal and needle bearing together by inserting the jaws of Pilot Bearing Remover 7600-E, Figure 29, through the seal and bearing to pull at "D", Figure 28.

6. Remove the intake valve seats from the body with Valve Seat Remover NCA-600-G, as shown in Figure 24.

C. Inspection

Vane Type Pumps:

1. After a pump has been disassembled, discard the old "O" rings, gaskets, and oil seal. Clean all parts thoroughly.

2. Inspect the cam ring, Figure 21, for signs of wear. If wear is noticeable or unevenness can be felt

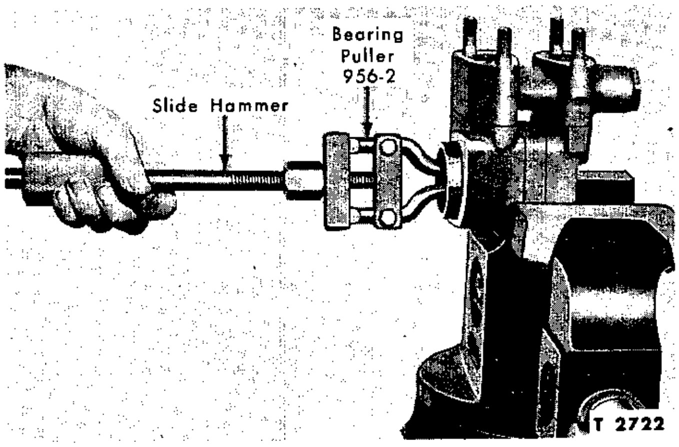


Figure 20—Removing Pump Shaft Oil Seal

with your finger, discard the rotor, cam ring and vanes and install a new kit.

3. Examine the pump rotor vane for wear by pulling the vane out to its normal operating position and moving it back and forth. If movement can be felt, discard the vanes, rotor and cam and install a new kit. Check the inside of the cam ring for having a sharp feather edge. Although the ring may be smooth, a feather edge indicates excessive wear and the assembly should be replaced.

4. Examine the shaft seal area. If roughness is evident, replace the assembly.

5. If the bearings run rough or if side movement is evident, replace them.

6. Check the flow control valve to see if it is free in the bore after assembly.

7. If the shaft bushing in the cover shows signs of damage, it should be replaced. All parts should be lubricated and the pump filled with oil immediately after repair.

Piston Type Pump:

1. After a pump has been disassembled, discard all old "O" rings, gaskets and oil seal. Clean all parts thoroughly.

2. Check all springs for distortion or breaks and replace them as required.

3. Inspect the body inlet valve seats for burrs, wear or out of round condition. Replace defective valve seats as required. Replace the body if any of the piston bores are scored or damaged.

4. Inspect the inlet and outlet valve balls for wear or scores. Replace as required.

5. Inspect the plate for damaged outlet valve seats or damaged or worn valve stop pins. Replace the plate if the seats are worn. Replace worn or damaged pins.

6. Examine each piston for galling or scores and replace as required. If scores are noted, the trac-

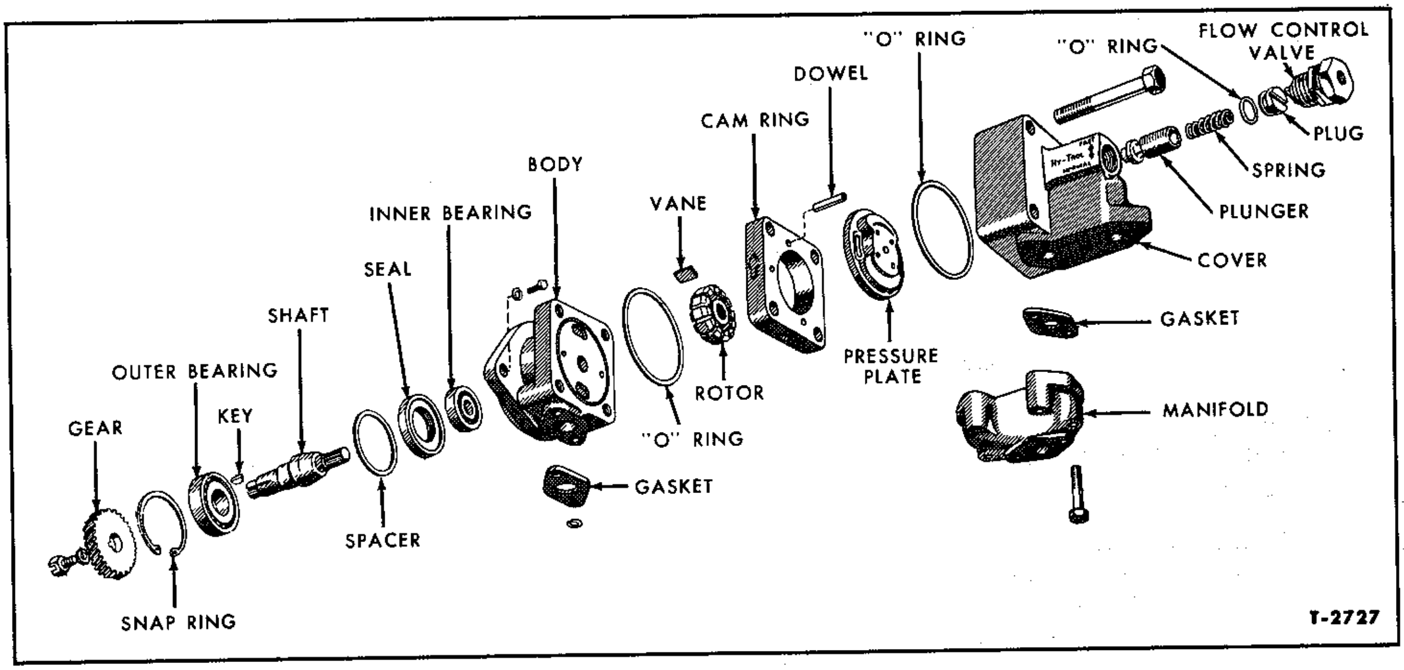


Figure 21—Vane Type Pump NAA—Disassembled

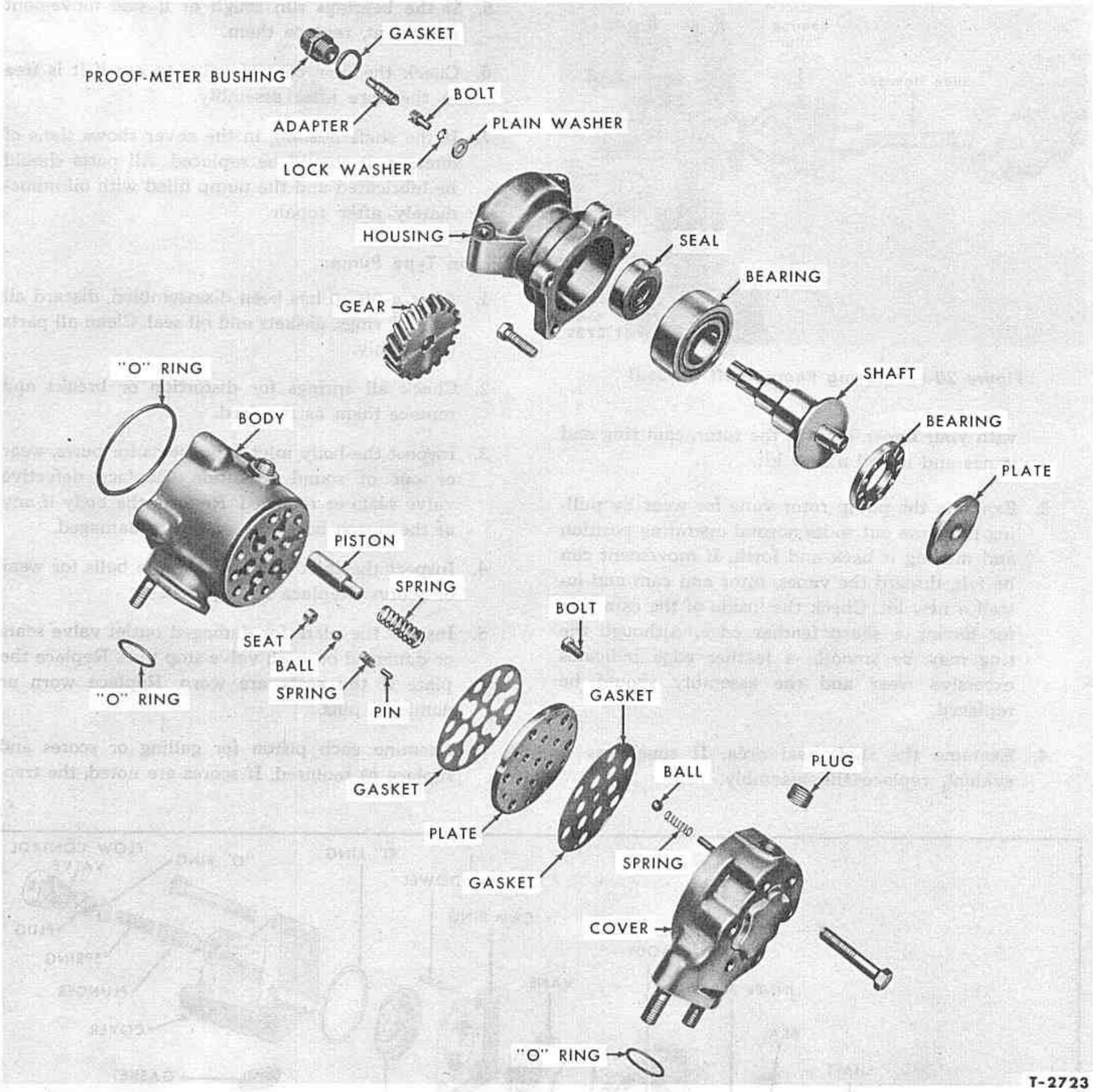


Figure 22—Ball Bearing Piston Type Pump—Disassembled

tor hydraulic system should be thoroughly flushed before the pump is installed on the engine.

7. Check the shaft seal area and bearing surface for wear or damage. Replace the shaft if either of these conditions are evident.

8. Inspect the plate and the bearing for wear or damage. Replace these parts as required.

9. Inspect the shaft roller bearing and cup or the double row ball bearing for roughness, wear or damage. Replace these parts as necessary.

D. Assembly

Vane Type Pump—Model 600, 700, 800 and 900 Tractors:

1. Place the pump body in a vise equipped with brass jaws.

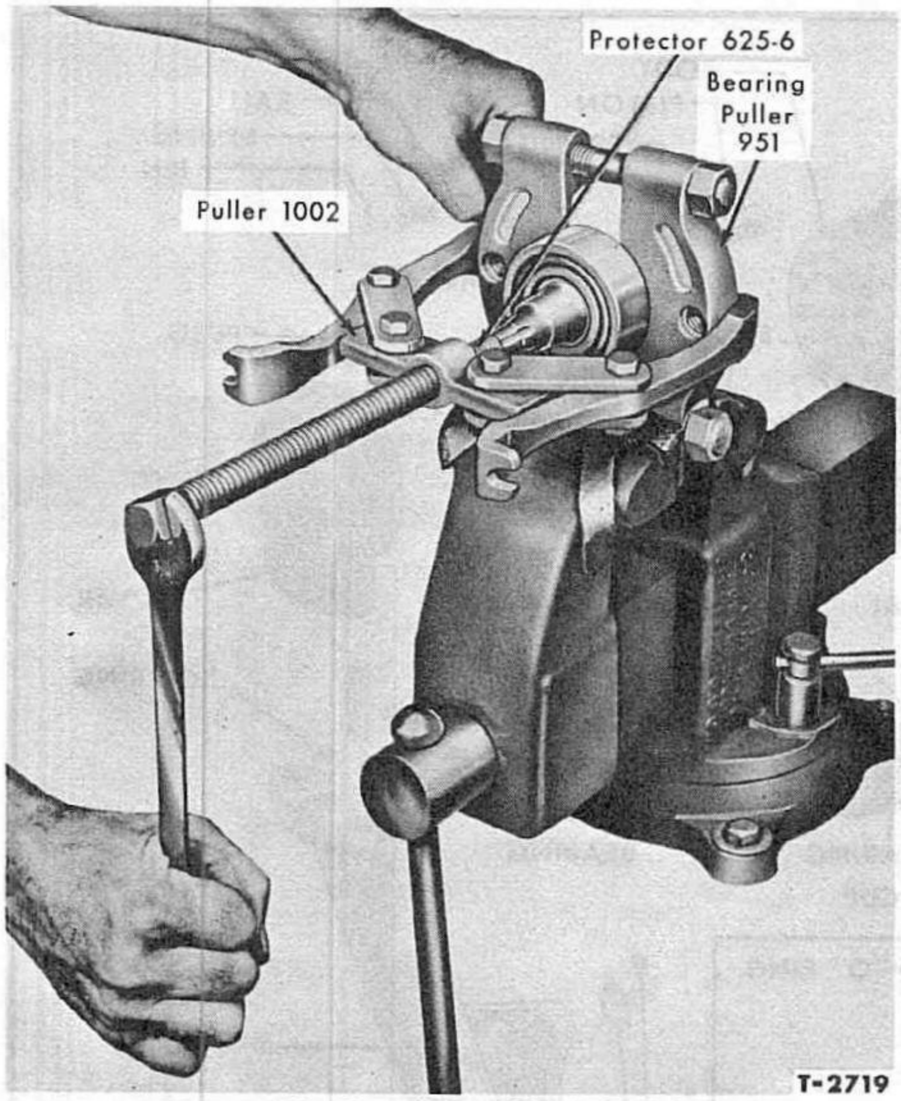


Figure 23—Removing Shaft Bearing

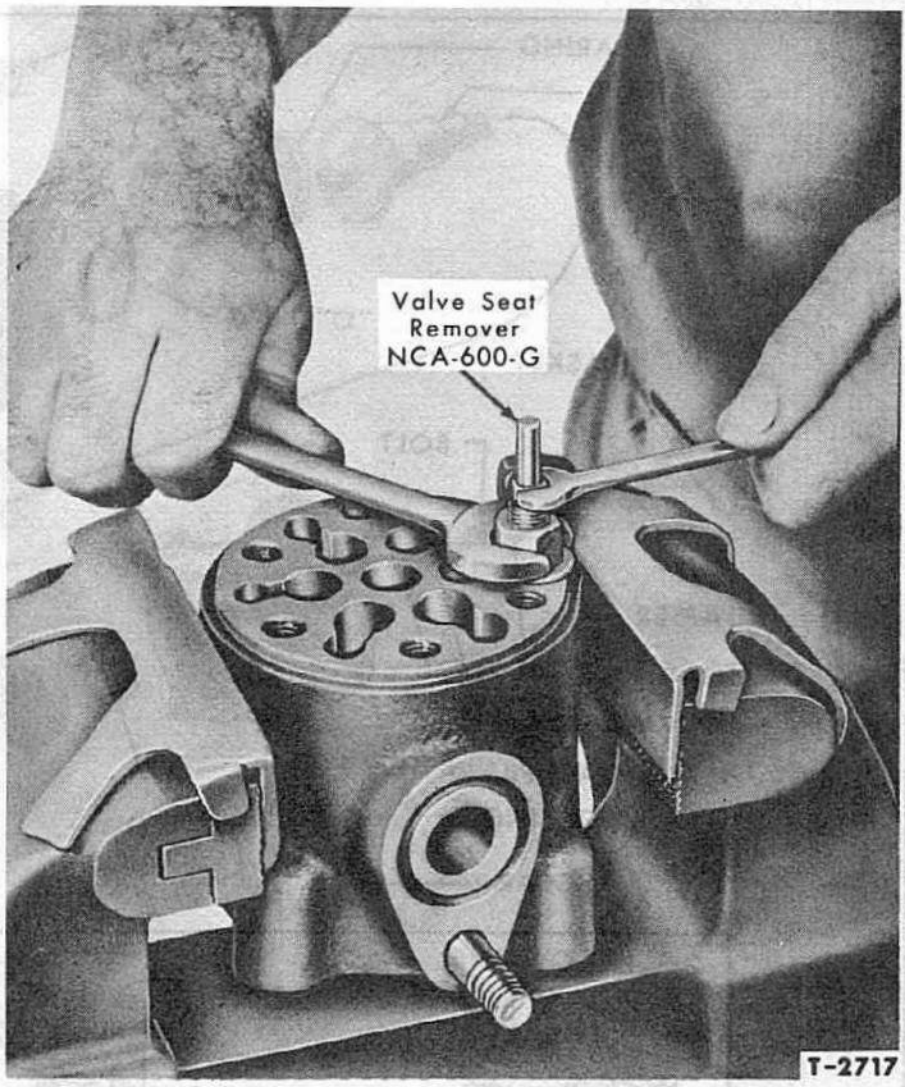


Figure 24—Removing Inlet Valve Seats from Body

2. Install the oil seal in the body with a driver and Step-Plate 630-5, Figure 30. Make certain that the small vent holes in the seal are toward the rear of the pump.

3. Press the rear of the shaft into the bearing. Dip the bearing into clean hydraulic oil.

4. Position the spring and "O" ring, Figure 19, on the pressure plate and install the pressure plate in the pump body.

   NOTE: ***If the two dowel pins were removed from the pump body, they must be installed before installation of the pressure plate.***

5. Install the rotor in the cam ring. Install the twelve vanes in the rotor, making certain that the rounded surface of each vane is toward the outside of the rotor.

6. Position a new "O" ring on the pump body. Install the cam ring on the body.

   IMPORTANT: ***The cam ring must be installed with the arrow pointing upward and be visible when the pump is mounted on the engine.***

7. Lubricate the rotor vanes and cam ring with clean hydraulic oil.

8. Press the shaft bushing into the pump cover if it was removed. Place a new "O" ring on the pump cover. Secure the cover to the body with two short bolts.

9. Install the key in the end of the shaft and slip the spacer in place in the shaft.

10. Position a new gasket on the pump body. Place the gear in the housing with the flat side of the gear toward the housing mounting flange. Install the housing on the body making sure that the shaft key is in alignment with the keyway in the gear. Secure the housing to the body with the two long bolts. Tighten the bolts evenly and alternately.

11. Secure the gear to the shaft with a flatwasher, lock washer and bolt, Figure 19.

12. Install the Proof-Meter adapter, new gasket and Proof-Meter bushing in the housing.

13. Install a new "O" ring on the control valve plug. Install the plunger, spring and plug in the flow control valve body.

14. Install two new "O" rings on the flow control lever and shaft. Install the assembly in the flow control valve body and secure with a roll pin.

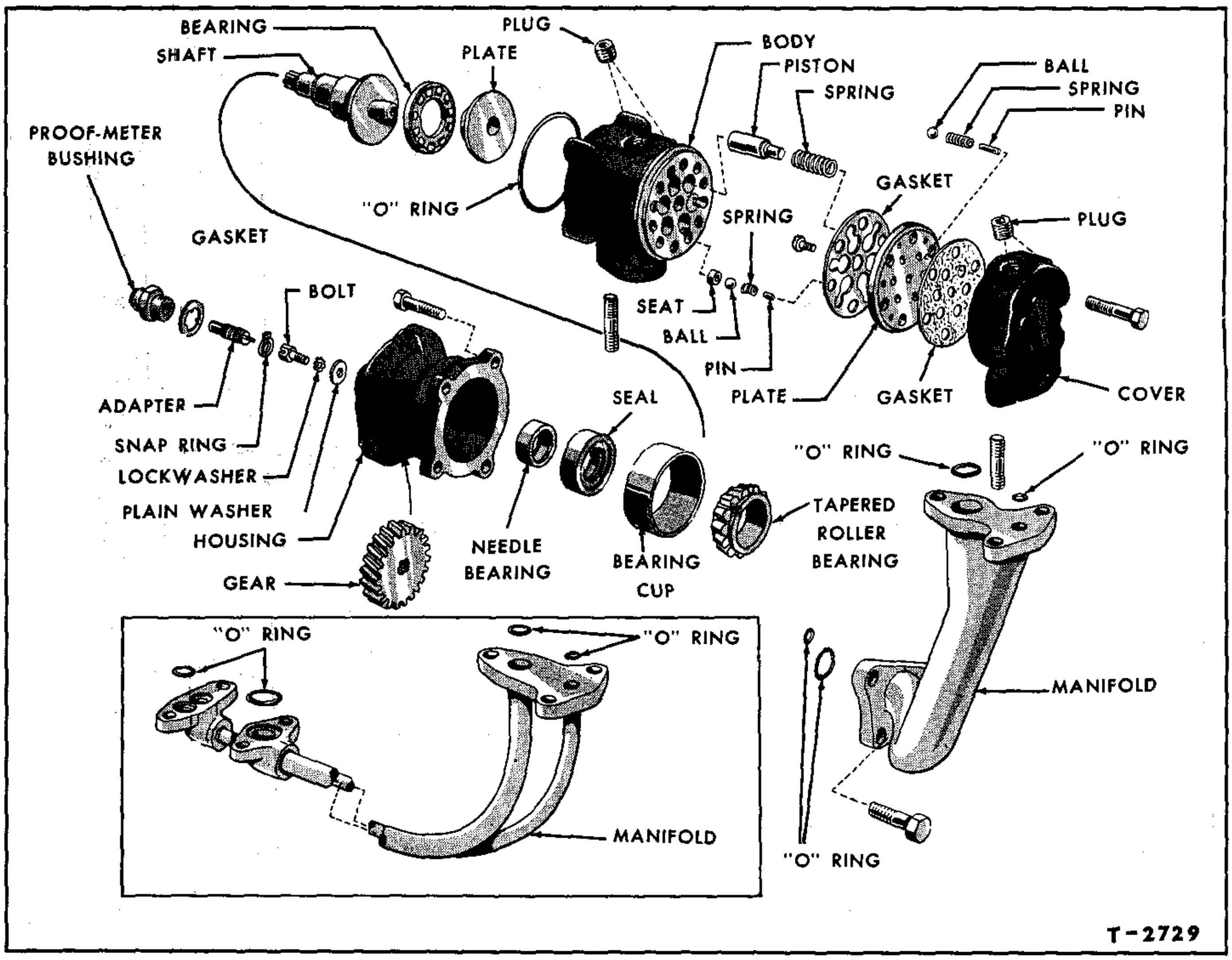


Figure 25—Roller Bearing Piston Type Pump—Disassembled

15. Position two new "O" rings on the flow control valve body. Secure the flow control valve body to the pump body with the two Allen head screws.

Vane Type Pump—NAA:

1. Install the inner bearing, Figure 21, in the pump body.
2. Install the seal in the body with a step plate, Figure 30, that contacts the outside diameter of the seal. Make certain that the vent holes in the seal are facing out.
3. Insert the dowel pins in the cam ring if they were removed. Position the pressure plate on the dowels.
4. Position the rotor in the cam ring and install the twelve vanes in the rotor with the rounded edge toward the cam ring, Figure 21.
5. Place a new "O" ring on the pump body and on the cover, Figure 21. Place the cam ring and rotor assembly on the body with the arrows at the side of the cam ring pointing to the left or counterclockwise direction as viewed from the shaft end of pump.
6. Secure the cover and new "O" ring to the body with the four attaching bolts.
7. Press the outer bearing on the shaft if it was removed. Install the shaft spacer, and bearing in the body and secure with the snap ring.
8. Install the plunger and spring in the cover, Figure 21. Install a new "O" ring on the plug. Install the plug and flow control valve in the cover.
9. Place the key in the end of the shaft. Install the

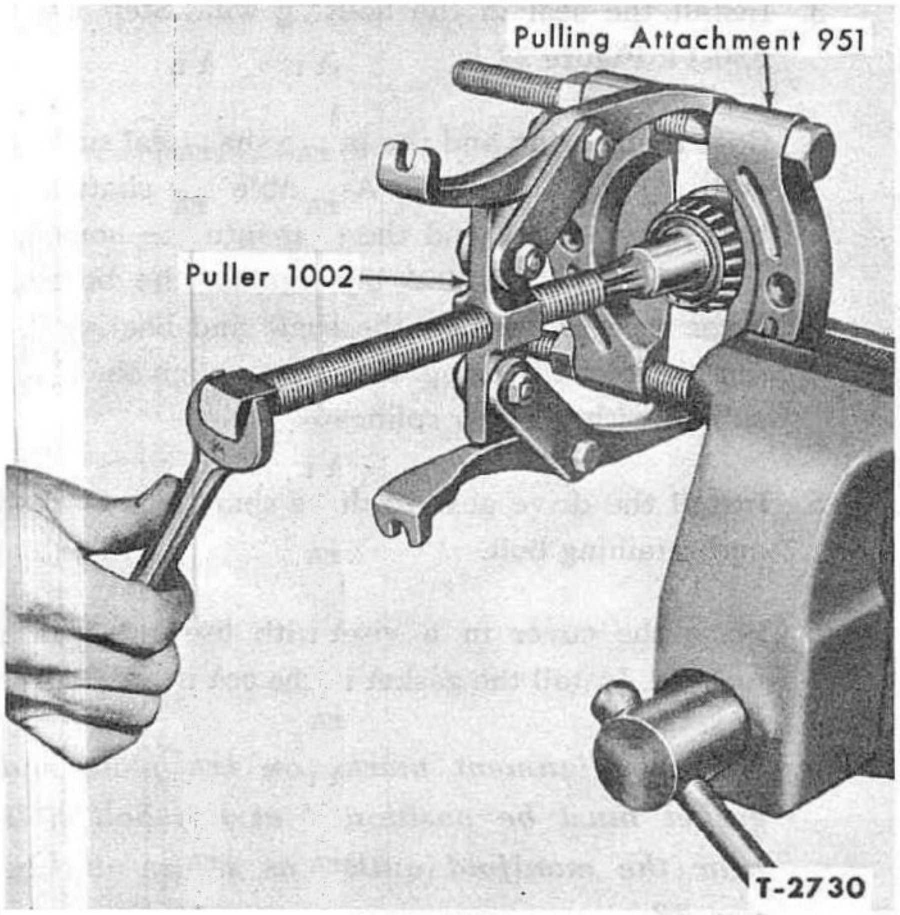


Figure 26—Removing Tapered Roller Bearing from Shaft

housing and gear on the shaft and body. Secure the body to the housing with two cap screws. Secure the gear to the shaft with a flat washer, lock washer, and bolt.

10. Install the Proof-Meter adapter, new gasket, and the bushing in the housing.

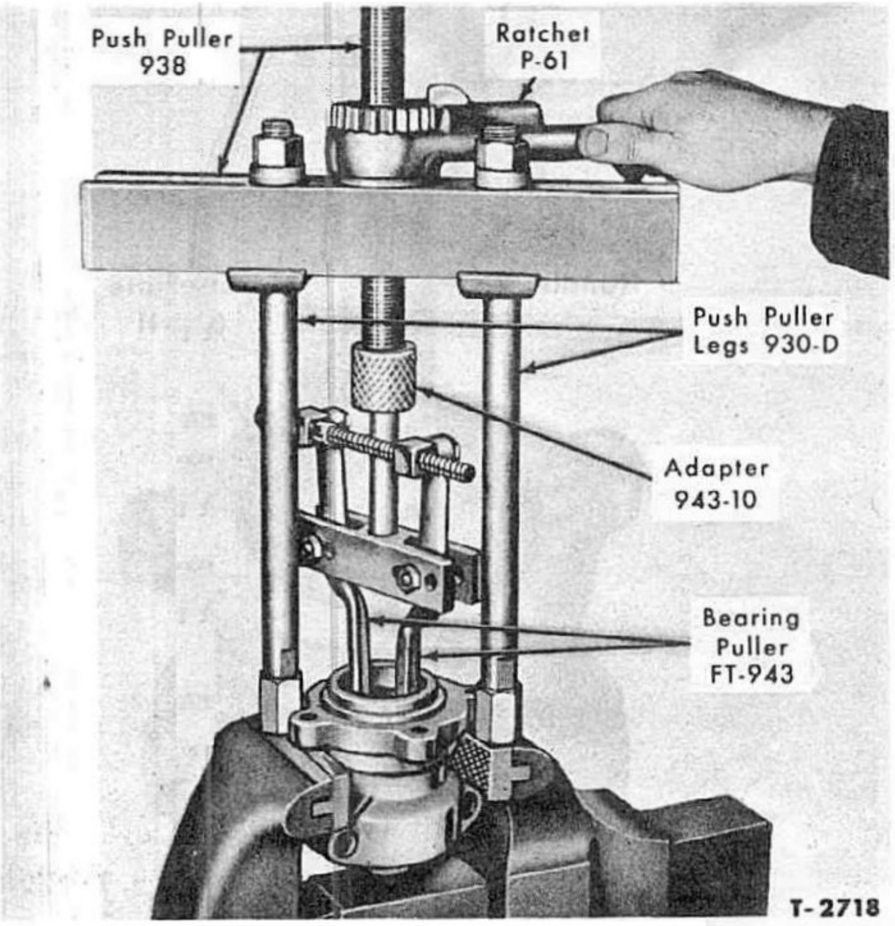


Figure 27—Removing Bearing Cup

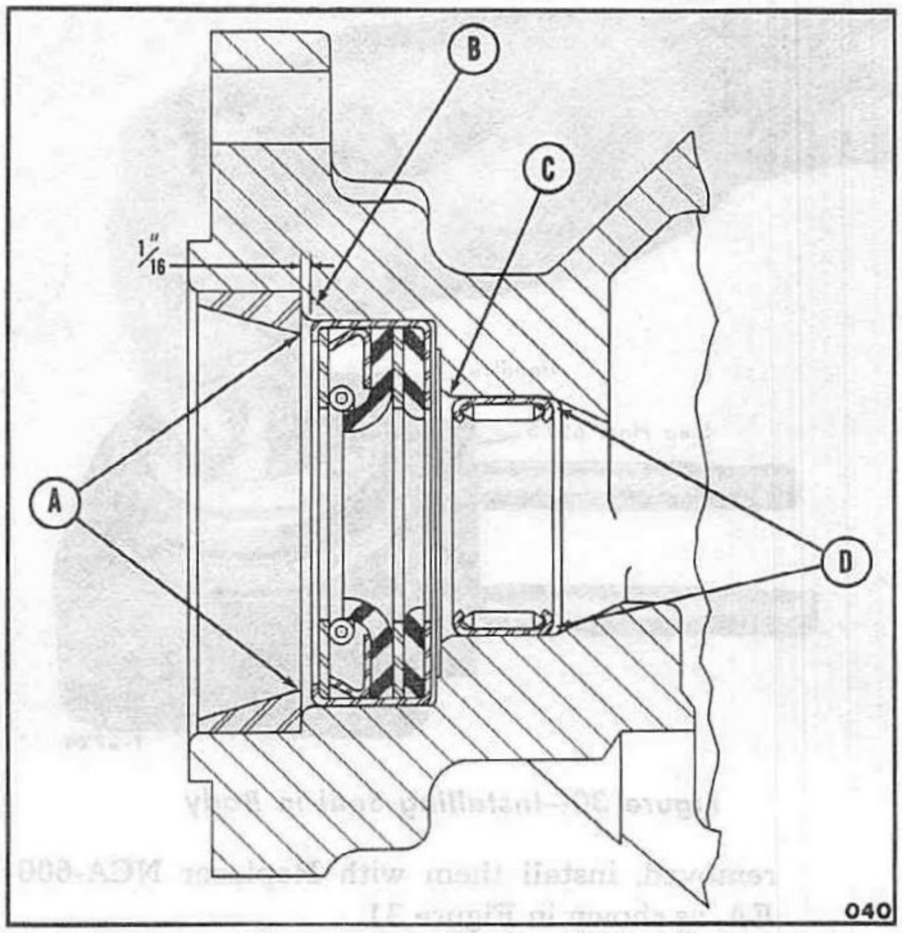


Figure 28—Bearing Cup, Seal and Needle Bearing Installation

11. Secure the manifold and two new gaskets to the body and cover with four bolts.

Ball Bearing Piston Type Pump:

1. If the inlet valve seats in the pump body were

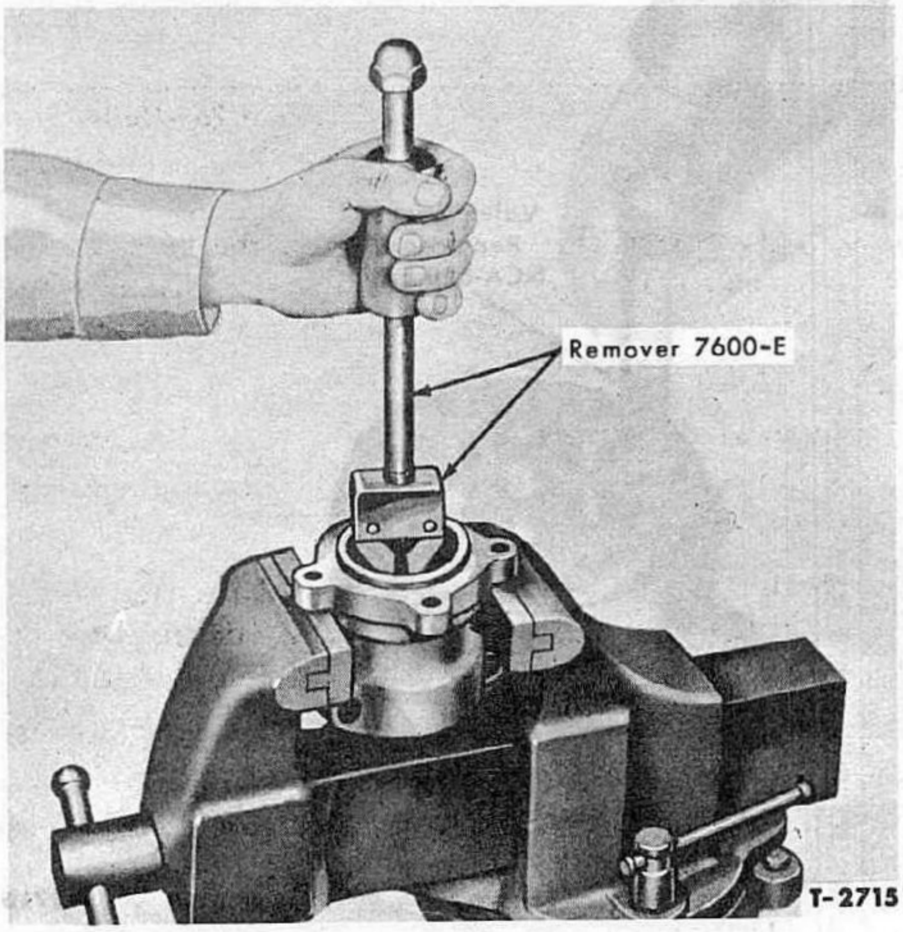


Figure 29—Removing Seal and Needle Bearing

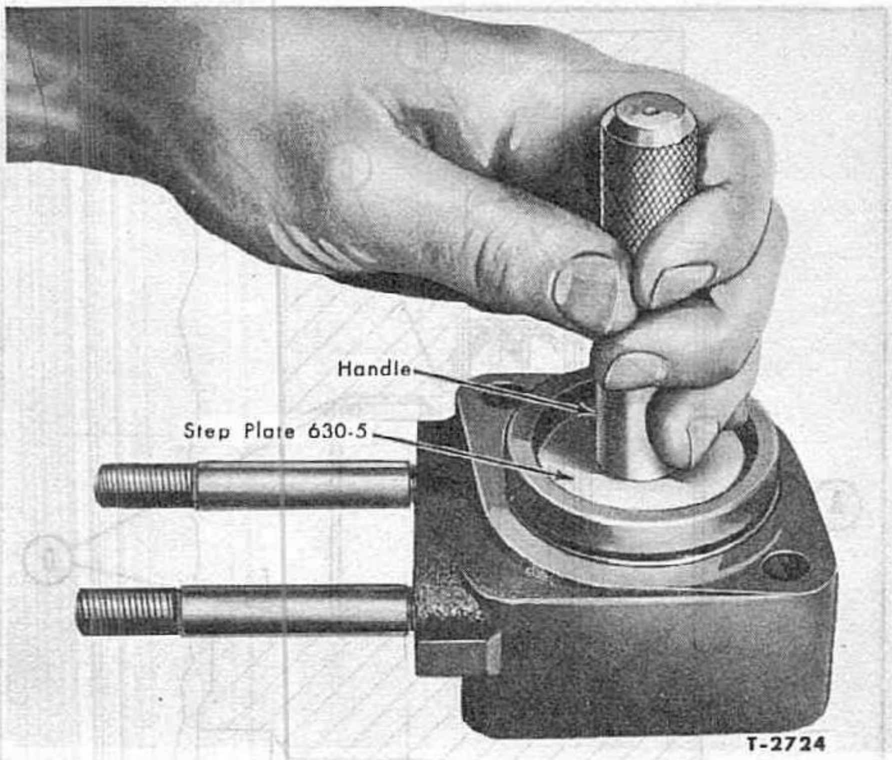


Figure 30—Installing Seal in Body

removed, install them with Replacer NCA-600-EA, as shown in Figure 31.

2. Press the bearing onto shaft until it bottoms on the shoulder.

   IMPORTANT: ***Use an adapter that contacts only the bearing inner race.***

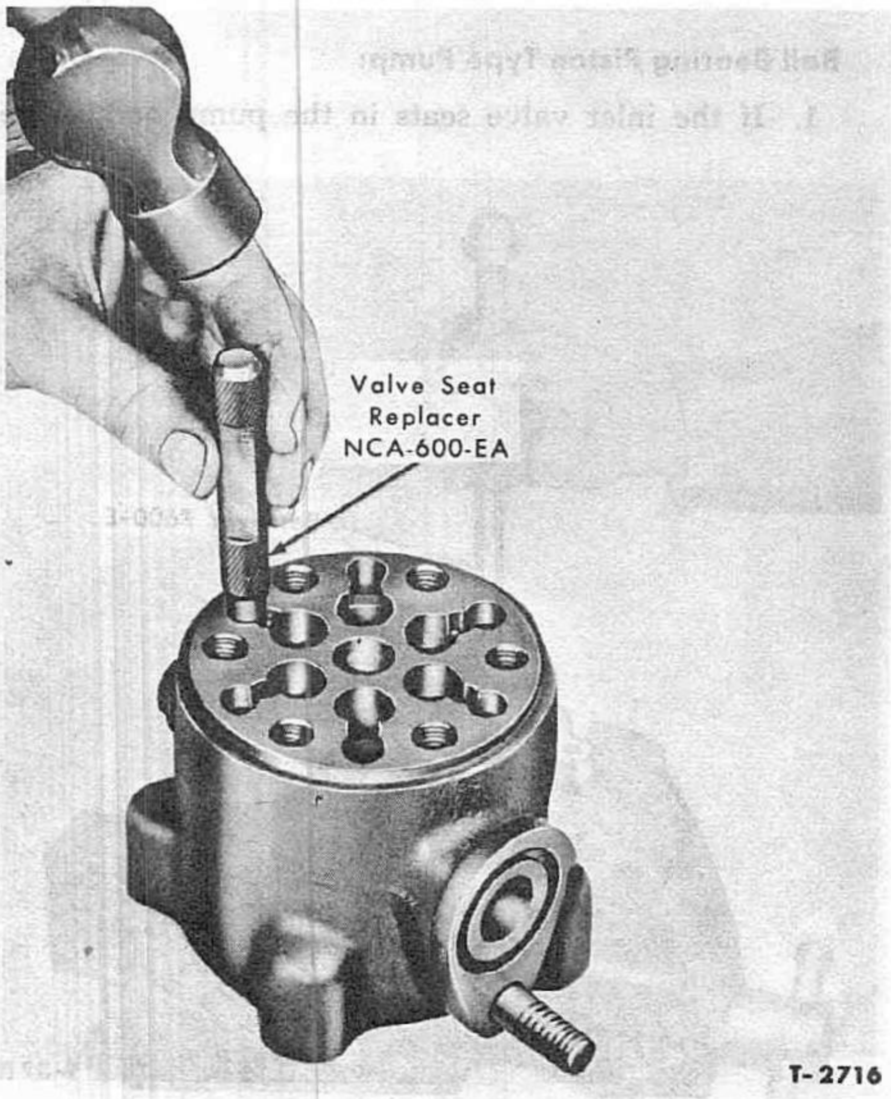


Figure 31—Installing Inlet Valve Seats

3. Install the seal in the housing with Step Plate 630-11, Figure 32.

4. Coat the bearing and the pump shaft seal surface with a light film of oil. Assemble the shaft and bearing assembly and the gear into the housing. Use a brass drift and tap against the bearing outer race to position the shaft and bearing assembly in the housing. Be sure to align the shaft splines with the gear splines.

5. Install the drive gear to drive shaft lock washer and retaining bolt.

6. Place the cover in a vise with the valve face upward. Install the gasket in the cover.

   NOTE: ***Alignment marks on the plate and gasket must be positioned at the bolt hole near the manifold outlet, as shown in Figure 33.***

7. Assemble the outlet valve return springs and outlet valve balls in the cover. Position the valve plate over the outlet valve balls and install

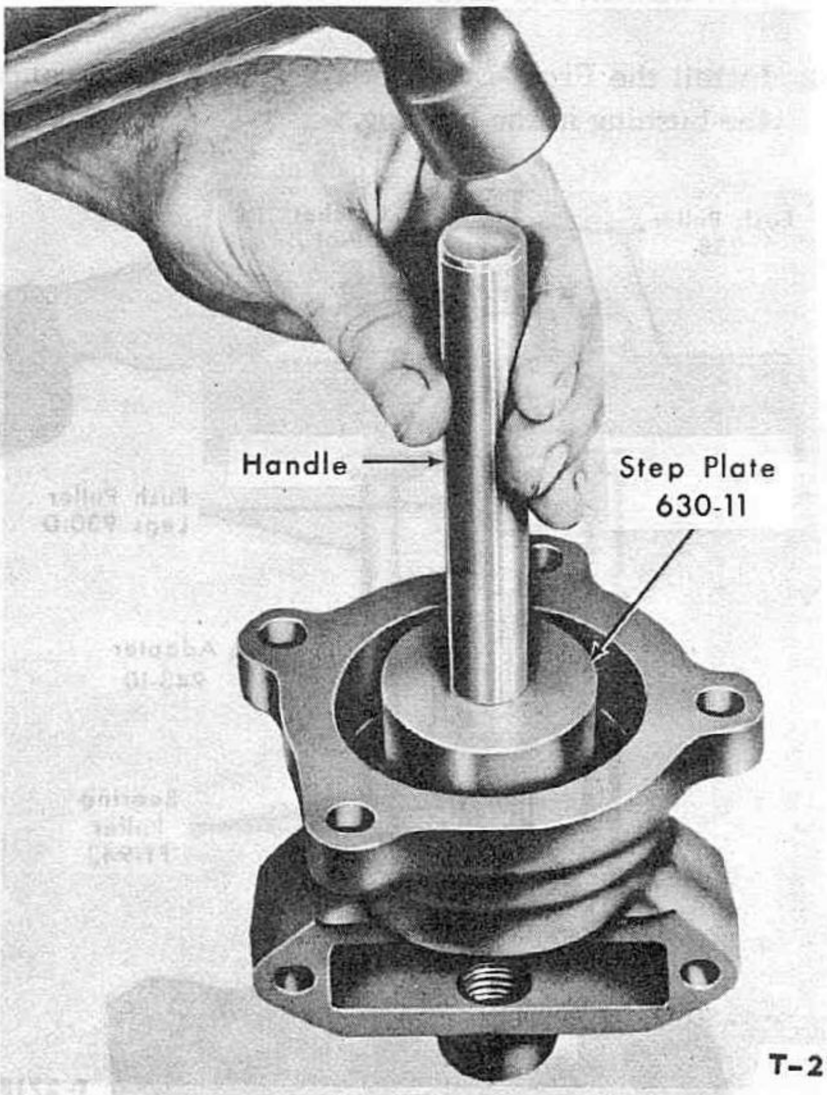


Figure 32—Seal Installation

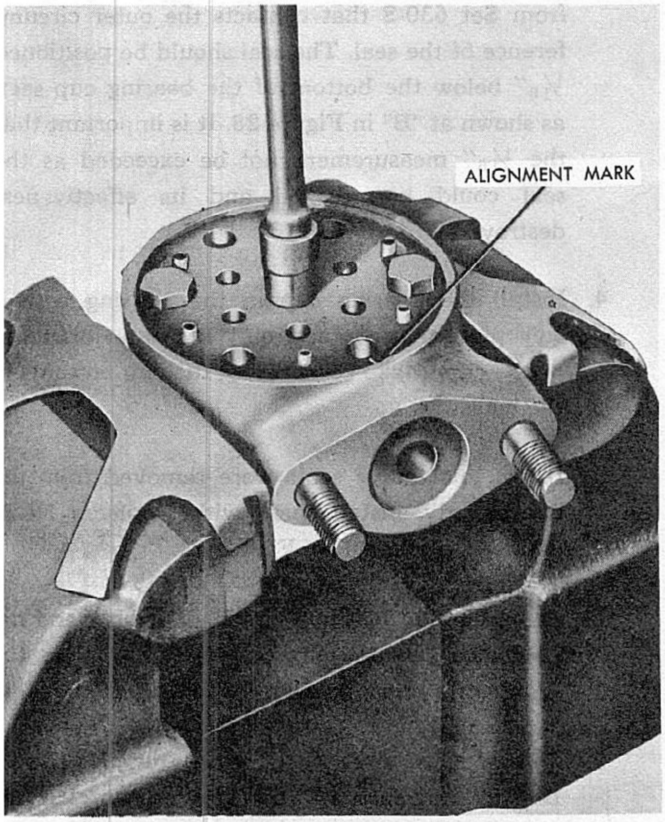


Figure 33—Plate Alignment Mark

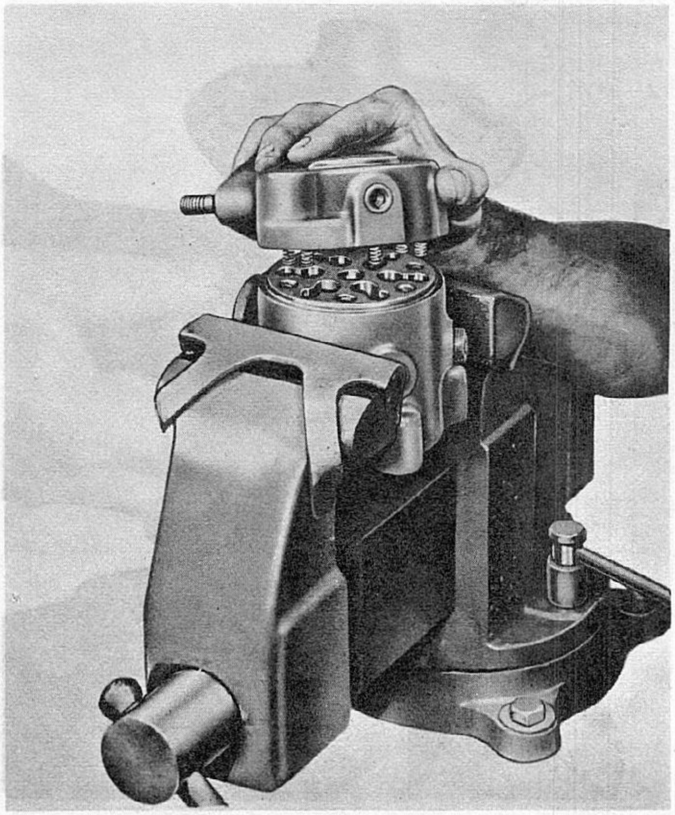


Figure 34—Installing Pump Cover

the center bolt loosely. Use two cap screws as shown in Figure 33, to hold the plate in alignment while tightening the plate attaching bolt.

8. Position the small end of the inlet valve springs on the stop pins in the plate. Remove the cover from the vise.

9. Position the six inlet valve balls in the pump body.

10. Carefully position the cover on the body as shown in Figure 34. Check the alignment of all springs, then secure the cover with the six attaching bolts. Tighten the bolts evenly and alternately to 40-50 ft. lbs. torque.

11. Invert the pump and install the six piston return springs in the body. Coat the pistons with oil, then install them in the bores with the crowned ends facing up, Figure 35.

12. Position a new "O" ring in the pump body groove. Place the bearing and wobble plate on the shaft. Install the housing and shaft assembly on the body, while holding the wobble plate as shown in Figure 35.

13. Press down on the housing and install the four attaching bolts. Tighten the bolts to 40-50 ft. lbs. torque.

14. Install the Proof-Meter assembly.

Tapered Roller Bearing Piston Type Pump:

1. Press the tapered bearing onto the shaft until it bottoms on the shoulder.

   IMPORTANT: ***Use an adapter that contacts only the bearing inner race. A piece of pipe 1¼" in diameter and 4½" long can be used as an adapter.***

2. Install the needle bearing in the gear housing with a socket large enough so that the I.D. seats on the outside top edge of the bearing. Drive the bearing in until the top of the bearing is flush with the step in the housing, then use a slightly smaller socket and drive the bearing until it is flush with the bottom of the chamber in the bore, as shown at "C" in Figure 28.

3. Install the seal in the housing with a step plate

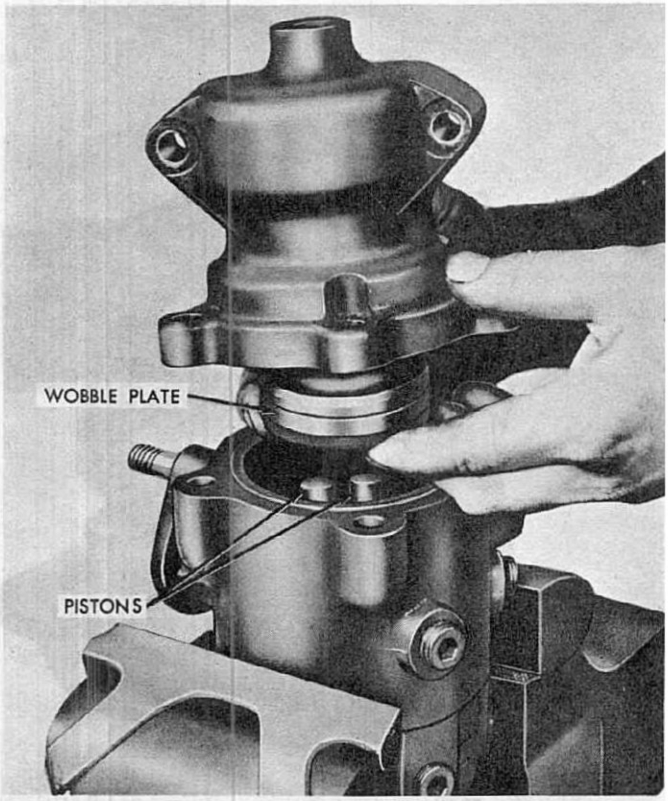


Figure 35—Installing Housing on Body

from Set 630-S that contacts the outer circumference of the seal. The seal should be positioned $\frac{1}{16}''$ below the bottom of the bearing cup seat, as shown at "B" in Figure 28. It is important that the $\frac{1}{16}''$ measurement not be exceeded as the seal could be crushed and its effectiveness destroyed.

4. Install the bearing cup in the housing with a step plate that contacts only the outer diameter of the cup. Make certain that the cup bottoms in the housing.

5. If the inlet valve seats were removed from the pump body, install them with Replacer NCA-600-EA, as shown in Figure 31.

6. Assemble the shaft and bearing assembly and the gear into the housing. Secure the gear to the shaft with a flat washer, lock washer, and bolt.

7. Follow steps 6 through 14 as detailed under Ball Bearing Piston Type Pump to complete the assembly procedure.

6. PUMP RELIEF VALVE AND OIL TUBES

The hydraulic system intake and pressure tubes extend through the transmission to connect the hydraulic manifold at the front of the transmission to the hydraulic sump in the center housing. The tubes are pressed into the transmission and have "O" rings in the counterbores at each end of the transmission to provide a leakproof seal.

The pump relief valve is located in the bottom of the center housing. The relief valve can be removed and installed without separating the center housing from the transmission.

A. Pump Relief Valve

1. Drain the hydraulic oil from the hydraulic system.

2. Remove the relief valve retaining plate, "O" ring and gasket.

3. Place a flat washer over the ¼ inch Unified National Course bolt and thread it into the relief valve.

4. Position a small block of wood on the housing and pry the valve out of the bore as shown in Figure 36.

   NOTE: ***If the relief valve can not be removed in this manner, it will be necessary to remove the lift cover and drive the valve out of the housing using a punch and hammer.***

5. Discard the "O" rings from the relief valve and remove the bolt.

6. Before installing a new relief valve, thoroughly clean around the bore and access plate mounting area.

7. Install new "O" rings on the relief valve and lubricate the valve surface and "O" ring with hydraulic oil.

8. Push the relief valve into the bore.

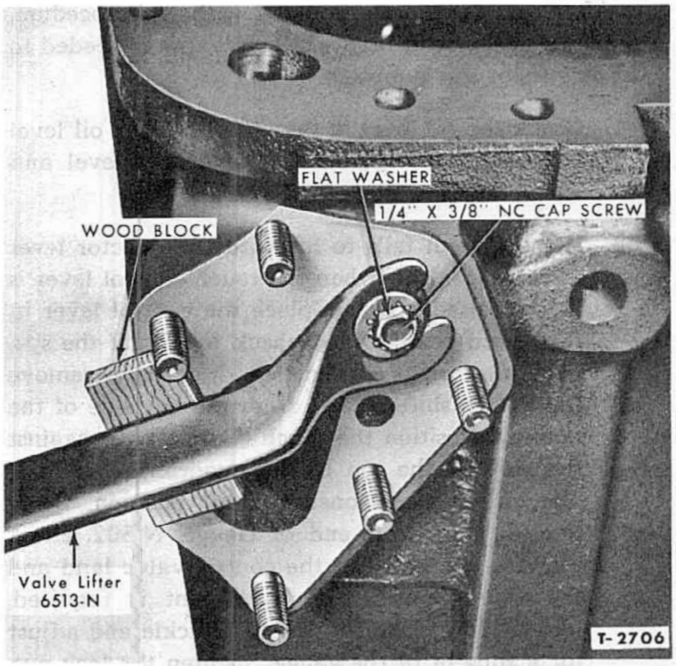


Figure 36—Removing Pump Relief Valve

9. Install a new gasket on the retainer plate and install the plate. Install the lock washers and nuts and tighten the nuts securely.

B. Hydraulic Tubes

1. Remove the transmission from the tractor.
2. Install Replacer NCA-945A in the pressure tube at the rear of the transmission, as shown in Figure 37 and drive the tube out of the transmission.
3. Use the same tool and drive a new tube in from the front of the transmission until it is properly positioned in the housing (tube should not protrude beyond face of housing).
4. Use Replacer NCA-945-B and drive the intake tube out from the rear of the transmission. Use the same tool and install a new tube through the front of the transmission as shown in Figure 38.

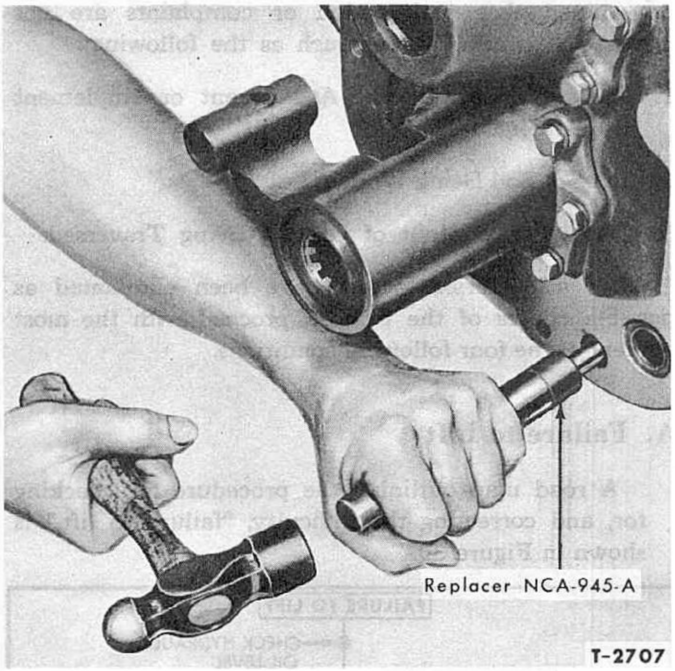


Figure 37—Removing Pressure Tube

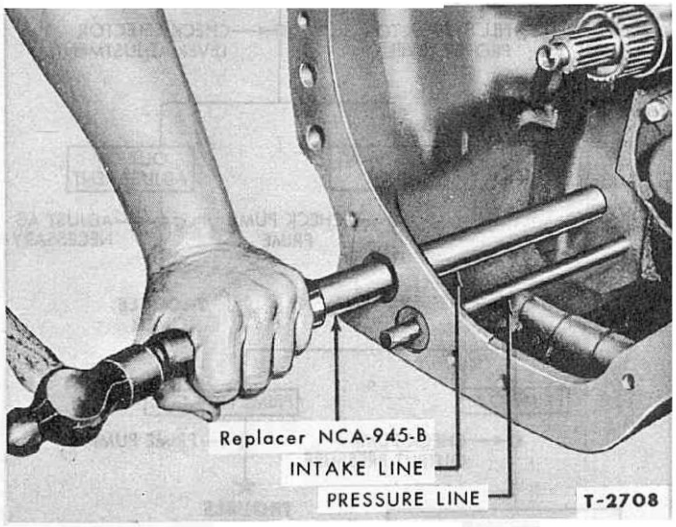


Figure 38—Installing Intake Tube

7. TROUBLE SHOOTING

Trouble in the hydraulic system can usually be traced to one of several causes by first determining what the end results or symptoms are. By observing the operation of the system, you will be able to determine which of the conditions listed below prevails.

Detailed instructions for locating the cause of the troubles are given under headings which are actually the conditions listed. The procedure for locating and correcting troubles is to consider the most likely cause first. Then, as possibilities are eliminated, the more serious causes are explored in the order in which they are likely to occur. In each case, the corrective action required is indicated.

In every case of hydraulic system trouble, certain preliminary steps should be taken before any attempt is made to correct the problem. It should be definitely determined that malfunction or complaints are not caused by exterior factors such as the following:

1. Method of Implement Attachment or Implement Adjustment.

2. Type of Soil Being Worked.

3. Terrain or Contour of Ground Being Traversed.

After all exterior factors have been eliminated as possible causes of the trouble, proceed with the most evident of the four following conditions.

A. Failure to Lift

A road map outlining the procedure for checking for, and correcting the difficulty, "failure to lift," is shown in Figure 39.

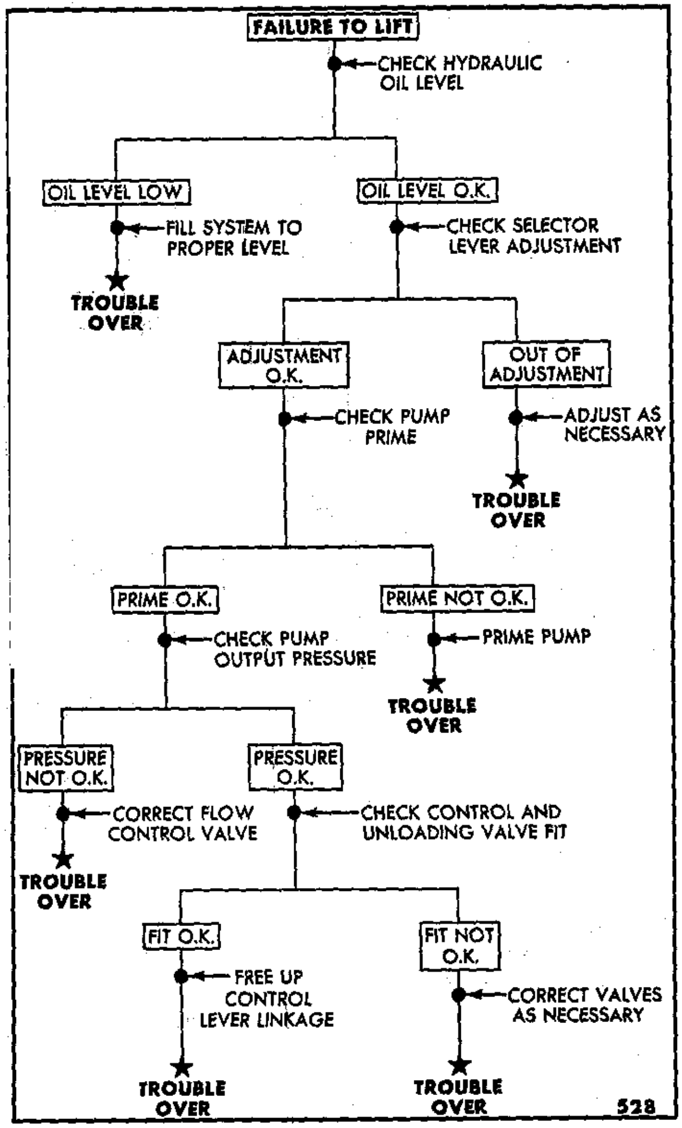


Figure 39—Failure to Lift—Road Map

After you familiarize yourself with the procedure, a glance at the road map will be all that is needed to trouble shoot this symptom.

1. Check the oil level in the system; if the oil level is low, fill the system to the proper level and check the operation of the system.

2. If the system fails to lift with the selector lever in constant draft when the touch control lever is in the raised position, place the control lever in the raised position and check for lift. If the system fails to lift in constant draft only, remove the P.T.O. shifter plate from the left side of the housing. Position the touch control lever against the stop at the top of the quadrant. Place the selector lever in constant draft position. Using the constant draft end of Gauge, N-502, check the distance between the control valve land and the valve housing. If adjustment is required, loosen the lock nut in the turnbuckle and adjust for a snug fit of the gauge. Tighten the lock nut, replace the P.T.O. shifter cover, start the engine and check the function of the lift. If the adjustment is satisfactory and no adjustment is needed, proceed with paragraph 3.

3. To separate pump malfunction from hydraulic lift cover malfunction, it will speed up the checking procedure if a substitute pump of known characteristics is used. If such a pump is not available, the following procedure should be used.

Roller Vane Pump: Remove the pipe plug from the lower right front side of the center housing. Place a container under the opening. Place the touch control lever down and start the engine. If oil is delivered from the pipe plug hole, the pump is primed and you can proceed with paragraph 4. If oil is not delivered from the hole, race the engine or apply air pressure to the center housing through the hydraulic dip stick hole until the pump is primed. Stop the engine and install a pressure gauge in the pipe plug hole. Start the engine and check for lift at the lift arms and for pressure at the gauge with a suitable implement attached to the lift arms. If pressure does not register satisfactorily, proceed with paragraph 4.

Piston Pump: Remove the Allen plug in the pump cover. Use the tractor starter to turn the engine over and check for oil delivery. If oil is delivered, replace the Allen plug before the oil stops flowing to prevent any air from entering the pump. If oil flows from the pump cover Allen plug hole, the pump is primed.

4. Check the pump prime for the respective pump as follows:

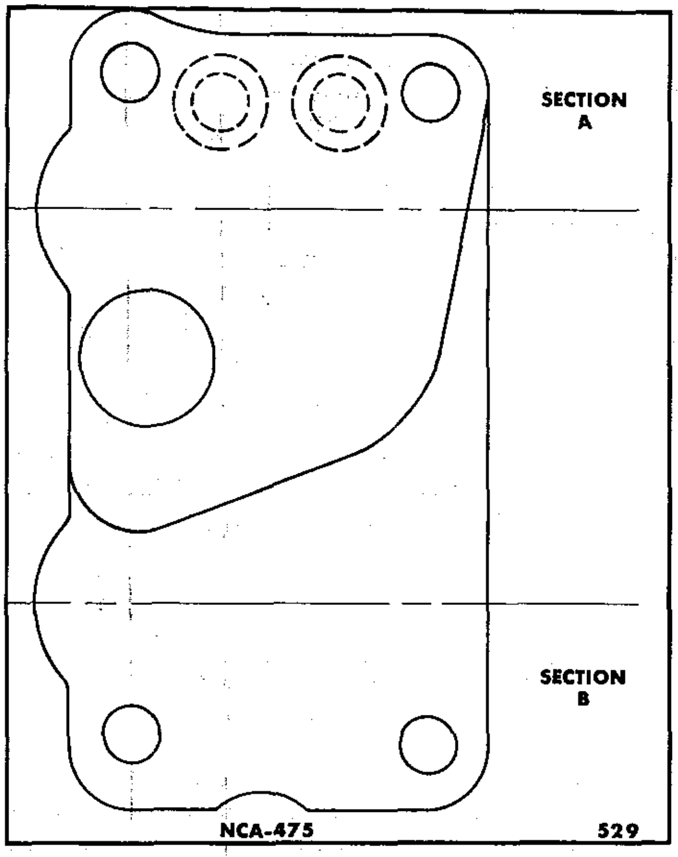


Figure 40—Accessory Plate Showing Test Set-Ups

Roller Vane Pump: Remove the flow control valve spring retainer plug from the front end of the pump flow control valve body.

NOTE: ***Use caution when removing the plug as it is spring loaded.***

Remove the spring and flow control valve.
Clean the valve thoroughly and inspect for burrs or any evidence of hanging up or galling. If damage is evident, polish the valve with Arkansas stone or crocus cloth to remove the burrs or metal build-up. Install the valve in the flow control valve housing and be sure it moves freely in the bore. Inspect the retaining plug "O" ring seal for damage before replacing the spring and retaining plug. Start the engine. Place the touch control lever in the raised position and check for lift. If the lift arms do not work, remove the lift cover assembly. Remove the accessory plate from the lift cover and install the portion shown at "A", Figure 40, on the center housing over the pressure tube.

Start the engine and observe the flow of oil into the reservoir. Move the flow control valve from high to low position with the engine operating at 1800 rpm, and observe the change in the oil flow to determine whether or not the valve is hanging up. Shut off the engine. Remove the accessory plate and install Gasket, Part No. NCA-502-A; turn the accessory plate 180° and install the portion indicated at "B", Figure 40, on the center housing, blocking off the pressure tube. Start the engine and run it at 600 rpm. This will determine whether or not the pump output is sufficient to actuate the relief valve which should be set at 2000 psi. If the relief valve operates properly, proceed with paragraph 5.

If the pump does not have sufficient pressure, replace the pump or repair it as necessary.

Piston Pump: To check the pump for output pressure, start the tractor engine. Place the touch control lever in the raised position and check for lift. If the lift arms do not function, check for pump output pressure by the following method: Stop the tractor engine and remove the pipe plug from the lower right front side of the center housing. Install a pressure gauge in the pipe plug hole. Remove the lift cover assembly from the tractor. Remove the Accessory Plate, Part No. NCA-475-E, from the lift cover and install the portion shown at "A", Figure 40, on the center housing and over the pressure tube.

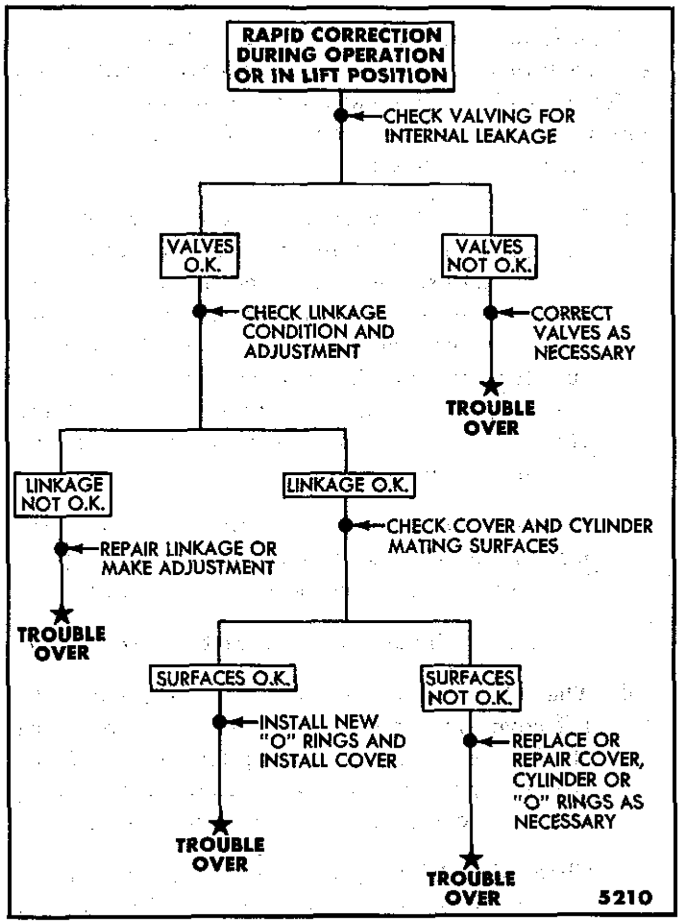

RAPID CORRECTION DURING OPERATION OR IN LIFT POSITION
CHECK VALVING FOR INTERNAL LEAKAGE
VALVES O.K.
VALVES NOT O.K.
CHECK LINKAGE CONDITION AND ADJUSTMENT
CORRECT VALVES AS NECESSARY
TROUBLE OVER
LINKAGE NOT O.K.
LINKAGE O.K.
CHECK COVER AND CYLINDER MATING SURFACES
REPAIR LINKAGE OR MAKE ADJUSTMENT
TROUBLE OVER
SURFACES O.K.
SURFACES NOT O.K.
INSTALL NEW "O" RINGS AND INSTALL COVER
REPLACE OR REPAIR COVER, CYLINDER OR "O" RINGS AS NECESSARY
TROUBLE OVER
TROUBLE OVER
5210

Figure 41—Rapid Corrections During Operation or in Lift Position—Road Map

Start the engine and observe the flow of oil into the reservoir. Note that the flow will increase with an increase in engine rpm. Shut the engine off, remove the accessory plate and install an "O" ring at pressure tube location, turn the accessory plate 180° and install the portion indicated at "B", Figure 40, on the center housing, blocking off the pressure tube.

Start the engine and run at 600 rpm. This will determine if the pump output pressure is sufficient to actuate the relief valve which should be set at 2000 psi. If the pump will actuate the relief valve, the pump output pressure is satisfactory.

5. Check the control valve to bushing fit for interference which would not allow the control valve to go into the lift position. Correct the valve action if necessary. Check the unloading valve and the "O" ring for proper functioning. Correct if necessary. If the valves operate properly, the difficulty is in the control lever linkage. Free up the linkage as necessary to insure free movement.

B. Rapid Corrections During Operation or in Lift Position

The Road Map for checking for, and correcting the condition of rapid corrections as shown in Figure 41.

This condition is usually caused by some form of internal leakage. The procedure for correcting the difficulty is as follows:

1. Remove the lift cover from the tractor. Remove the check valve ball and examine the surface for erosion marks. Check the condition of the gasket and the washer under the bolt. Check the control valve surfaces for erosion and scratches and be sure the valve fits the bushing properly. Examine the plug for leakage, then remove the plug and check the press fit to see if there is a good sealing surface on both the plug and the cylinder.
2. Remove and inspect the unloading valve and also inspect the "O" ring. Replace or repair parts as necessary to correct any valve leakage.
3. Inspect the linkage to be sure there is no bind.
4. The "O" rings between the lift cylinder and the lift cover should be checked for damage. Check the ball seal and the "O" ring for damage. When the lift cylinder is removed from the lift cover, check the cover mating surfaces for cracks.
5. Check the "O" ring and leather backing washer on the piston and check the cylinder bore for scoring. Reassemble the lift cover, using new "O" rings, and make the proper adjustment using Gauge N-502. Install the lift cover on the tractor and check for leakage. Leak-down, to the point of a correction, should not occur more than ten times a minute.

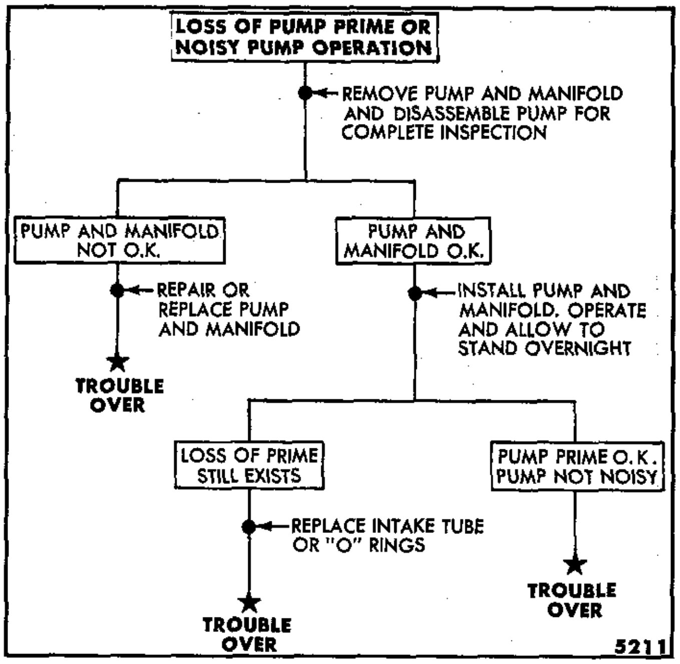

LOSS OF PUMP PRIME OR NOISY PUMP OPERATION
REMOVE PUMP AND MANIFOLD AND DISASSEMBLE PUMP FOR COMPLETE INSPECTION
PUMP AND MANIFOLD NOT O.K.
PUMP AND MANIFOLD O.K.
REPAIR OR REPLACE PUMP AND MANIFOLD
INSTALL PUMP AND MANIFOLD. OPERATE AND ALLOW TO STAND OVERNIGHT
TROUBLE OVER
LOSS OF PRIME STILL EXISTS
PUMP PRIME O.K. PUMP NOT NOISY
REPLACE INTAKE TUBE OR "O" RINGS
TROUBLE OVER
TROUBLE OVER
5211

Figure 42—Loss of Pump Prime or Noisy Pump Operation—Road Map

C. Loss of Pump Prime or Noisy Pump Operation

The road map for checking for, and correcting the symptom, Loss of Prime or Noisy Pump Operation, is shown in Figure 42.

If the preliminary inspection does not reveal the difficulty, the trouble is probably due to air in the system. Use the following procedure to find the source of air leakage.

1. Remove the pump and manifold from the tractor.
2. Disassemble the pump and inspect the "O" rings. Inspect all the pump castings for cracks, porosity or any other defects that might cause leakage. Inspect the manifold "O" rings for defects and the manifold castings for defects or porosity. Replace parts as necessary to repair pump and manifold condition.
3. Reassemble the pump and install the pump and manifold on the tractor. Use all new "O" rings. Fill the hydraulic reservoir.
4. Operate the lift arms several times and then allow the tractor to stand overnight to determine if loss of prime still exists.

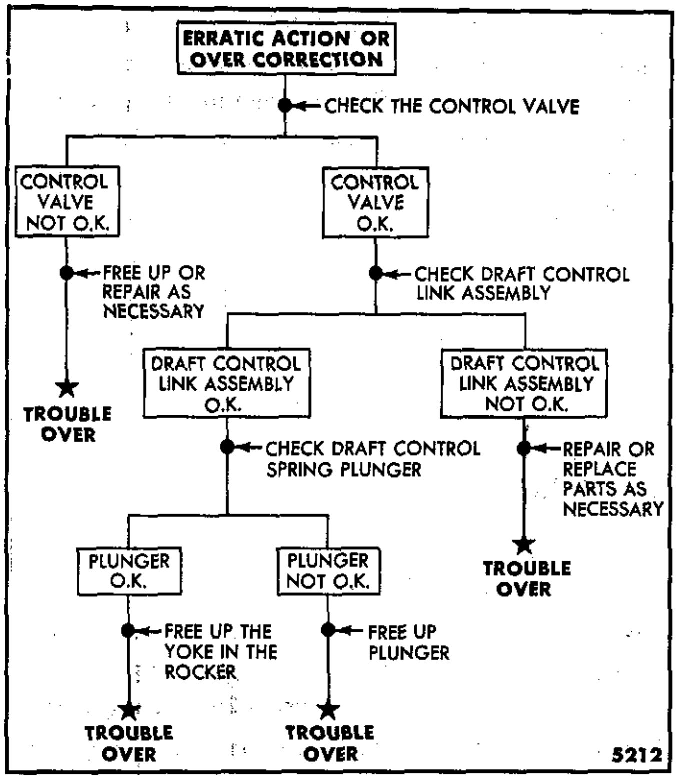

ERRATIC ACTION OR OVER CORRECTION
CHECK THE CONTROL VALVE
CONTROL VALVE NOT O.K.
CONTROL VALVE O.K.
FREE UP OR REPAIR AS NECESSARY
CHECK DRAFT CONTROL LINK ASSEMBLY
TROUBLE OVER
DRAFT CONTROL LINK ASSEMBLY O.K.
DRAFT CONTROL LINK ASSEMBLY NOT O.K.
CHECK DRAFT CONTROL SPRING PLUNGER
REPAIR OR REPLACE PARTS AS NECESSARY
PLUNGER O.K.
PLUNGER NOT O.K.
TROUBLE OVER
FREE UP THE YOKE IN THE ROCKER
FREE UP PLUNGER
TROUBLE OVER
TROUBLE OVER
5212

Figure 43—Erratic Action or Over Correction—Road Map

5. If loss of prime is still prevalent, remove the transmission from the tractor and remove the hydraulic intake tube from the transmission. Inspect the tube for possible leakage and observe the press fit into the transmission housing. Replace the tube in the housing and install the transmission in the tractor. Inspect all points of possible leakage and use all new "O" rings and seals.

D. Erratic Action or Over Correction

The symptom, Erratic Action or Over Correction, is usually caused by an inoperative control valve or binding in the control valve linkage. A road map to follow in trouble shooting this symptom is shown in Figure 43.

1. Remove the lift cover from the tractor.
2. Check for free movement of the control valve. Check the draft control link assembly for score marks where the draft control bushing may be hanging up. Check the draft control spring plunger for free movement on the guide pin installed in the plate.
3. Make any corrections necessary and install the lift cover assembly. Check to be sure the yoke moves freely in the rocker before installing the pin.

E. Loss of Pump Prime or Erratic Lift Operation—Piston Pump

A road map outlining the procedure for checking and correcting, "Loss of Prime or Erratic Lift Operation," is shown in Figure 44. If the preliminary inspection does not reveal the difficulty, the trouble is probably due to air in the system. Before trying to locate a source of air leak, attempt to bleed air from the system by removing the prime plug in the piston pump cover. Turn the engine over with the starter and permit oil to escape momentarily. When it appears that all air bubbles have escaped, install the prime plug before oil stops flowing. If operation is not improved after the above procedure, drain the hydraulic oil and remove the pump and manifold from the tractor. Disassemble the pump and inspect the shaft seal and the body to gear housing "O" ring. Inspect the piston springs and pistons for breakage or seizure. Check the inlet and outlet valve springs, balls, stop pins and seats.

Inspect all the pump castings for cracks, or any other defects that might cause leakage. Inspect the manifold "O" rings and the manifold casting for defects. Replace parts as necessary to repair the pump and manifold. Reassemble the pump and install the

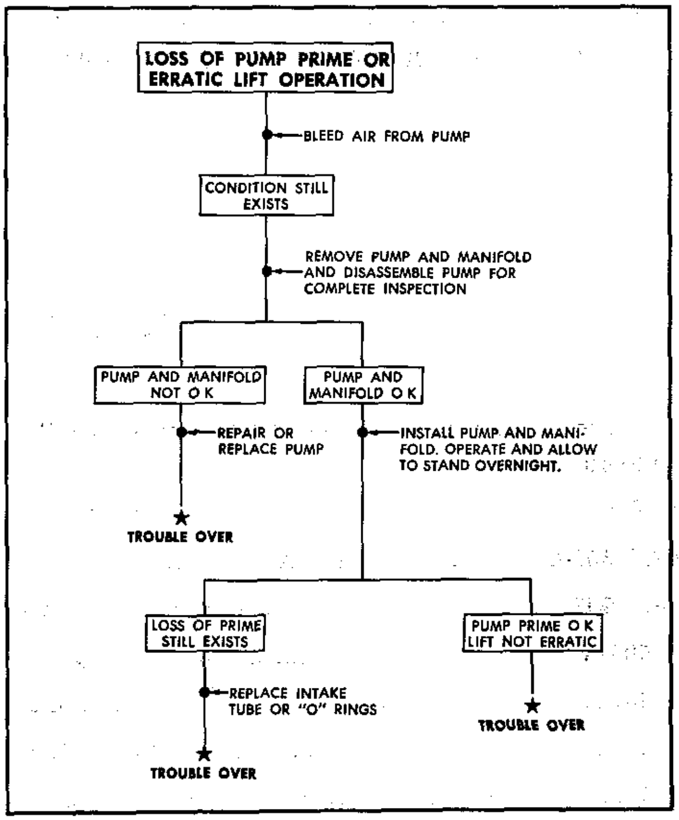

LOSS OF PUMP PRIME OR ERRATIC LIFT OPERATION
BLEED AIR FROM PUMP
CONDITION STILL EXISTS
REMOVE PUMP AND MANIFOLD AND DISASSEMBLE PUMP FOR COMPLETE INSPECTION
PUMP AND MANIFOLD NOT O K
PUMP AND MANIFOLD O K
REPAIR OR REPLACE PUMP
INSTALL PUMP AND MANIFOLD. OPERATE AND ALLOW TO STAND OVERNIGHT.
TROUBLE OVER
LOSS OF PRIME STILL EXISTS
PUMP PRIME O K LIFT NOT ERRATIC
REPLACE INTAKE TUBE OR "O" RINGS
TROUBLE OVER
TROUBLE OVER

Figure 44—Loss of Prime or Erratic Lift Operation—Road Map

pump and manifold on the tractor. Use all new "O" rings. Fill the hydraulic reservoir. Operate the lift arms several times, then allow the tractor to stand overnight to determine if loss of prime still exists. If loss of prime is still prevalent, remove the transmission from the tractor and remove the Hydraulic Intake Tube, Part No. NDA-941-C. Inspect the tube for possible leakage and observe the press fit into the transmission housing. Replace the tube in the housing and install the transmission in the tractor. Inspect all points of possible leakage and use all new "O" rings and seals.

8. SPECIFICATIONS

Hydraulic System

Capacity	8 U. S. Quarts
Type	Live Action
Maximum Pressure	2000 lbs. psi
Control	Implement position or constant draft

Vane Type Pump—
Model 600, 700, 800 and 900

Drive	Gear
Capacity	4 to 4.8 gpm at 0 psi at 2000 rpm (engine)

Vane Type Pump—NAA

Drive	Gear
Capacity (Hy-Trol in "Fast" position)	4.8 gpm at 0 psi at 2000 rpm (engine)
Capacity (Hy-Trol in "Slow" position)	1.25 gpm at 100 psi at 2000 rpm (engine)

Piston Pump

Drive	Gear
Capacity	4 gpm at 0 psi at 2000 rpm (engine)

9. SPECIAL TOOLS

The following special tools are required to service the hydraulic system:

Tool No.	**Description**
NCA-503-B	Lift Arm Positioning Gauge
NCA-997	Remover and Replacer
N-508-A	Remover and Replacer
943-S	Slide Hammer
956-2	Puller Jaws
951	Bearing Pulling Attachment
1002	Puller
625-A	Shaft Protector Set
NCA-600-G	Valve Seat Remover
943	Bearing Pulling Attachment
943-10	Adapter
930-D	Push Puller Legs
938	Push Puller
P-61	Ratchet Wrench
7600-E	Remover
630-S	Step Plate Set
NCA-699-EA	Replacer

Part FIVE

MAINTENANCE AND LUBRICATION

Section — Page
1 Maintenance 415
2 Lubrication 415

1. MAINTENANCE

MAINTENANCE GUIDE	Each 10 hrs.	Each 100 hrs.	Each 200 hrs.	Each 400 hrs.	Each 600 hrs.
Check for Oil Leaks		X			
Fuel Filter (Drain)			X		
Diesel Fuel Filter (Replace)				X	
Diesel Fuel Injectors (Clean and Test)					X
Check Coolant Level	X				
Check Fan Belt and Power Steering Belt Adjustment		X			
Check and Adjust Brakes			X		
Check Tire Pressure	X				
Check Electrolyte Level in Battery	X				
Check Clutch Pedal Free Travel			X		
Adjust Transmission Bands (Select-O-Speed)					X
Check Headlamps and Taillamp Operation			X		
Tighten all Electrical Connections					X
Perform Minor Tune-Up					X
Perform Major Tune-Up			*		
Replace Select-O-Speed Transmission Filter					X
Check for Correct Wheel Bearing Adjustment			X		
Check Wheel Lug Nuts for Tightness			X		
Check Gauges for Proper Operation			X		
*Every 1200 Hours					

2. LUBRICATION

It is extremely important that all moving parts are lubricated at the proper interval with the correct lubricant.

The following guide describes in hourly intervals, all of the lubrication services which a Ford Tractor should receive. The lubrication chart for "General Purpose" tractors is shown in Figure 1. A similar chart showing lubrication points for "Row Crop" tractors is provided in Figure 2. Figure 3 illustrates the lubrication points for the "Industrial" tractor.

A. Service Daily or Every 10 Hours

1. **Crankcase Ventilating System:** Remove the element from the Rocker Arm Cover breather and clean it with solvent. Coat the element lightly with engine oil before replacing it.

2. **Oil Filler Breather Cap:** Remove the element from the cap, clean the entire assembly with solvent, coat the element lightly with engine oil and replace it.

3. **Air Cleaner:** Wash the air intake screen with solvent and clean the oil cup. Fill the cup or tray to the oil level mark with engine crankcase oil. Both the air cleaner and the pre-cleaner (diesel only) should be inspected frequently when first operating under dusty conditions to determine the correct servicing interval. Under severe dusty conditions, service the cleaner at least twice daily.

4. **Pressure Gun Fittings:** Clean the fittings on the Lift Rod Leveling Box and Lock, the Front Axle Spindles ("General Purpose" and "Industrial"), the Clutch Pedal and the Steering Drag Links. Any dirt left on the fittings may be forced into the bearings and cause unnecessary wear. Apply pressure gun grease to all the fittings and wipe the fittings clean.

5. **Crankcase Dipstick:** Remove the dipstick from the right side of the engine crankcase. Always wipe the dipstick with a clean cloth. Replace it, then remove it to determine the engine oil level. Maintain the level at the full mark with the recommended lubricant (See Service Every 100 Hours).

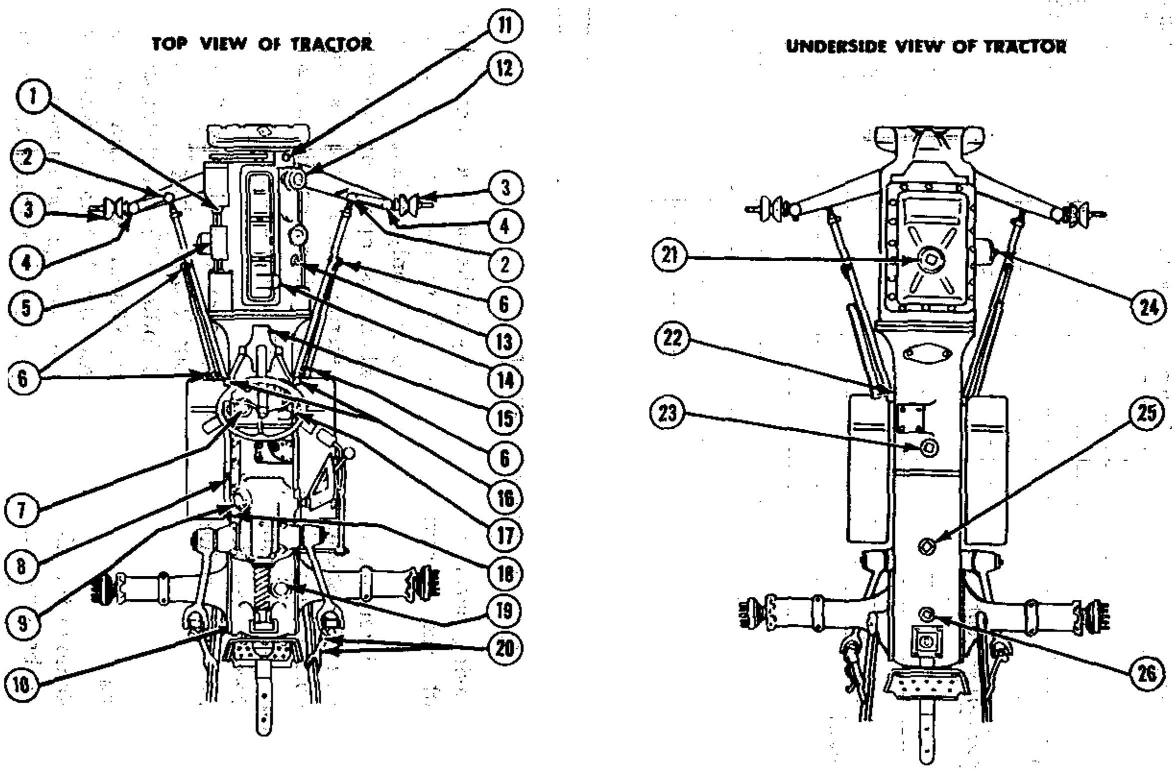
LUBRICATION CHART

EVERY 10 HOURS

- **14 CRANKCASE VENTILATING SYSTEM**—Clean and Oil
- **5 AIR CLEANER**—Clean and Oil
- **13 CRANKCASE DIP STICK**—Check Oil Level
- **18 HYDRAULIC SYSTEM DIP STICK**—Check Oil Level

LUBRICATE PRESSURE FITTINGS BELOW:

- **2 DRAG LINKS (FRONT)**
- **6 POWER STEERING CYLINDER**
- **4 SPINDLE PINS**
- **6 DRAG LINKS (REAR)**
- **8 CLUTCH PEDAL**
- **10 LEVELING BOX**



EVERY 600 HOURS

- **3 FRONT WHEEL BEARINGS**—Repack with High Grade Short Fiber Grease (Ford Spec. M4664)
- **23 and 7 4-SPEED TRANSMISSION**—Drain and Refill. Use Mild Extreme Pressure Lubricant SAE 80. Both Summer and Winter.
- **25 and 9 HYDRAULIC SYSTEM**—Drain and Refill (Below 10° F.—Mix 6 Qts. M4864A with 2 Qts. M4864D) (Above 10° F.—8 Qts. M4864A) or 8 Qts. M2C41 at any temperature
- **26 and 18 REAR AXLE**—Drain and Refill Use Mild Extreme Pressure Lubricant SAE 80, Both Summer and Winter.
- **FUEL INJECTORS**—Clean and test (diesel only)

EVERY 1200 HOURS

- **22 SELECT-O-SPEED TRANSMISSION**—Drain and refill after the first 50 hrs. and every 1200 hrs. thereafter. Use M2C41 summer and winter.

EVERY 100 HOURS

- **11 PUMP RESERVOIR**—Check oil level and replenish with M2C41 Ford Universal Hydraulic Lubricant.
- **21 and 11 ENGINE CRANKCASE**—Drain and Refill: Winter (Below 32° F.) S.A.E. 10—10W Summer (Above 32° F.) S.A.E. 20 or 30
- **DISTRIBUTOR**—A few drops of engine oil in cup. Do not over lubricate (Gasoline and LP-Gas only)
- **10 and 19 REAR AXLE**—Check Oil at Level Plug on Side of Housing and Add Oil if Necessary.
- **17 and 7 4-SPEED TRANSMISSION**—Check oil at level plug on side of housing and add oil if necessary.
- **22 SELECT-O-SPEED TRANSMISSION**—Check oil at level and filler plug on side of housing and add oil, if necessary. Use only M2C41 Ford Universal Hydraulic Lubricant.
- **15 STEERING HOUSING**—Check Oil Level.

EVERY 200 HOURS

- **24 OIL FILTER**—Replace every other engine oil change and add one quart of oil to fill new cartridge.
- **1 GENERATOR**—Oil rear bearing with light oil. Do not over lubricate.

EVERY 400 HOURS
(Diesel only)

FUEL FILTER—Replace element

T-2901

Figure 1—Lubrication Chart—General Purpose Tractors

6. **Hydraulic System Dipstick:** Check the level of the oil on the dipstick and maintain it at the full mark with the recommended lubricant (See Service Every 600 Hours). When checking the hydraulic oil level, always be sure that all hydraulic cylinders are fully extended.

B. Service Every 100 Hours

1. **Distributor:** Apply a few drops of seasonal engine oil to the oil cup (gasoline and LP-Gas models only). Do not over lubricate.

2. **Engine Crankcase:** Change the engine oil at the 50-hour inspection and after every 100 hours of operation thereafter. Drain the oil after the engine has reached normal operating temperature. Fill the crankcase with five quarts of oil when the filter cartridge is replaced. The following list shows the viscosity of oil that should be used for the various temperature ranges.

   SAE 30—Temperatures consistently above 90° F.
   SAE 20—Temperatures between 90° F. and 32° F.
   SAE 20W—Temperatures between 32° F. and 10° F.
   SAE 10W—Temperatures between 10° F. and — 10° F.
   SAE 5W—Temperatures below —10° F.

   In industrial and agricultural service, the crankcase oil is frequently subjected to extremely high operating temperature. Consequently, the oil is more subject to deterioration. Varnish on the pistons, valve stems, and tappets causes sluggish operation of the engine. Sludge may eventually clog the oil pump screen, the oil passages, and the oil control rings, resulting in bearing failure or excessive piston ring wear. The American Petroleum Institute (A.P.I.) has designed a method for the classification of motor oils so that oil can be selected for the type of operation, temperatures and operating conditions experienced. The A.P.I. classification and a brief description of the type of service for which each particular oil should be used, is as follows:

   SERVICE MS Motor Oil, which meets the requirements of A.P.I. classification *Service MS*, is recommended for use in all Ford Gasoline and LP-Gas engines under the most severe service conditions. This type of operation includes the most severe loads and temperature variation. Intermittent operation during cold winter temperatures and light loads promotes condensation, oil dilution and sludge formation. High summer temperatures and heavy-load service promotes oxidation of the lubricating oil and may cause high temperature varnish and sludge deposits. Service MS motor oils contain detergent compounds that tend to hold in suspension the foreign contaminants which would normally deposit on the engine parts.

   DM or SUPPLEMENT 1 (S-1) Motor Oil, which meets the requirements of A.P.I., is satisfactory in Ford diesel engines used for general tractor operation.

   DS or (SERIES 3) Motor Oil, which meets the requirements of A.P.I., is satisfactory for all types of operation in Ford diesel engines and strongly recommended when any one or a combination of the following conditions may be encountered:

   a. High air temperatures,
   b. Intermittent operation at low temperature,
   c. Fuel contains high sulphur content.

3. **Rear Axle:** Remove the rear axle oil level plug and check the level of the oil. Add oil if necessary (See Service Every 600 Hours).

4. **Final Drive Housing:** Remove final drive housing inspection plug ("Row Crop" models only) and check the oil level. Add oil as required (See Service Every 600 Hours).

5. **Transmission:** Remove the transmission oil level plug and check the level of the oil. Add oil as required (See Service Every 600 Hours).

6. **Steering Housing:** Check the oil level at the steering gear case plug and add lubricant as required. Use extreme pressure gear lubricant, SAE 90 in summer and SAE 80 in winter. Check the oil level in the power steering pump and replenish as necessary. Use only M2C41 oil in the power steering system.

7. **Pedestal:** Remove the tractor radiator grille and the pedestal filler opening plug. Wipe the plug dry and reinsert it into the opening, tightening to finger tightness. Remove the plug and check the oil level as indicated by the oil level mark. Add oil if necessary. (See Service Every 600 Hours.)

C. Service Every 200 Hours

1. **Oil Filter:** Replace the filter cartridge at the time of every other oil change. Add one quart of oil to the regular crankcase fill amount to fill the cartridge.

2. **Distributor:** Remove the cap and dust shield. Wipe the cam, the outside of the distributor, the wires and the coil clean with a clean cloth. Apply a thin film of distributor lubricant to the dis-

LUBRICATION CHART

EVERY 10 HOURS

3 AIR CLEANER—
Clean and oil.

7 HYDRAULIC SYSTEM DIP STICK—
Check oil level.

13 CRANKCASE DIP STICK—Check oil level.

14 CRANKCASE VENTILATING SYSTEM—
Clean and oil.

LUBRICATE PRESSURE FITTINGS BELOW

5 CLUTCH PEDAL— 4 SPEED ONLY

10 DRAG LINK (FRONT)

12 CONTROL VALVE AND CYLINDER ASSEMBLY

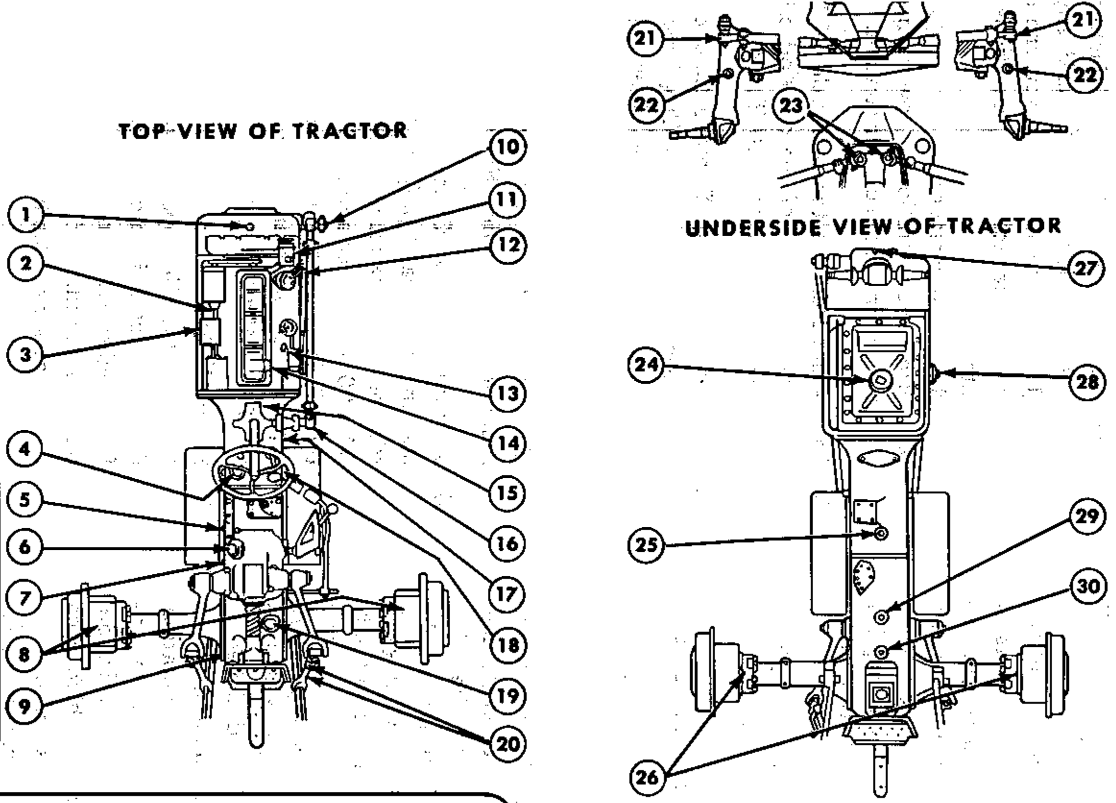
16 DRAG LINK (REAR)

20 LEVELING BOX

21 TIE RODS

22 SPINDLE PINS

23 TIE RODS



EVERY 600 HOURS

FRONT WHEEL BEARINGS—(Not shown) Repack with (M 4664) short fiber grease.

25 and 4 4-SPEED TRANSMISSION—Check oil at level plug on side of housing and add oil if necessary.

~~**27 PEDESTAL**—Drain and~~ and 1 refill. Use E. P. Lubricant SAE 80, both summer and winter.

29 and 6 HYDRAULIC SYSTEM—Drain and refill. (Below 10° F.—Mix 6 Qts. M. 4864 A with 2 Qts. M 4864 D) (Above 10° F.—8 Qts. M 4864 A or M 2C41

30 and 19 DIFFERENTIAL—Drain and refill. Use mild E. P. Lubricant SAE 80, both summer and winter.

FUEL INJECTORS—
Clean and test
(diesel only)

EVERY 1200 HOURS

17 SELECT-O-SPEED TRANSMISSION—After first 50 hours and at 1200 hours thereafter, drain and refill using M 2C41 Lubricant both summer and winter.

EVERY 100 HOURS

11 PUMP RESERVOIR—Check oil level and replenish with M 2C41 Ford Universal Hydraulic Lubricant.

24 ENGINE CRANKCASE—Drain and refill: Winter (Below 32° F.) SAE 10W or 20W; Summer (Above 32° F.) SAE 20; (above 90° F.) SAE 30

9 and 19 DIFFERENTIAL—Check oil at level plug on side of housing and add oil if necessary.

8 FINAL DRIVE—Check oil level.

18 and 4 4-SPEED TRANSMISSION—Check oil at level plug on side of housing and add oil if necessary. Use mild E. P. Lubricant SAE 80, both summer and winter.

17 SELECT-O-SPEED TRANSMISSION—Check oil at level and filler plug on side of housing and add oil, if necessary. Use only M-2C41 Ford Universal Hydraulic Lubricant.

8 HYDRAULIC SYSTEM—Check oil level.

19 STEERING HOUSING—Check oil level.

1 PEDESTAL—Check oil level.

DISTRIBUTOR— A few drops of engine oil in cup. Do not over lubricate
(Gasoline and LP-Gas only)

EVERY 200 HOURS

DISTRIBUTOR— Lubricate distributor cam with a film of Ford distributor grease
(Gasoline and LP-Gas only)

28 OIL FILTER—Replace cartridge every other engine oil change and add one extra quart of oil to fill crankcase.

2 GENERATOR—Oil rear bearing with light oil. Do not over lubricate.

EVERY 400 HOURS

FUEL FILTER—Replace element.

T-2903

Figure 2—Lubrication Chart—Row Crop Tractors

tributor cam. Use Ford Distributor Lubricant only.

3. **Generator:** Oil the generator rear bearing (bushing type only) with light oil. Do not over lubricate.

D. Service Every 400 Hours

1. **Fuel Filter:** Replace the diesel fuel filter element and bleed the system.

E. Service Every 600 Hours

1. **Front Wheel Bearings:** Clean the inner and outer front wheel bearings thoroughly with solvent and repack them with a high grade short fiber grease. Lubricate the spindle shaft before replacing the bearing.

2. **Four or Five-Speed Transmission:** Change the transmission oil at the 50-hour inspection and every 600 hours of operation thereafter. In winter, operate the tractor to thin the oil before draining the transmission. Fill the four-speed transmission with 6 quarts of extreme pressure lubricant and the five-speed transmission with 8 quarts. Use mild extreme pressure lubricant, SAE 80, for both summer and winter operation.

3. **Select-O-Speed Transmission:** The Select-O-Speed Transmission is hydraulically operated and pressure lubricated so it is very important that the proper lubrication level be maintained at all times. When adding lubricant, use only M2C41 Ford Universal Hydraulic Lubricant. The oil should be changed every 1200 hours and at the time of major service or overhaul.

   Check the oil level by removing the oil level check and filler plug, and add oil as required. Always use the utmost caution to insure that no foreign materials enter the transmission reservoir when either removing the filler plug or adding oil to the transmission.

   The transmission bands should be adjusted every 600 hours to assure transmission performance and prevent premature failure of the bands or clutches.

4. **Hydraulic System:** Change the oil in the hydraulic system at the 50-hour inspection and every 600 hours of operation thereafter. In winter, operate the system to thin the oil before draining. Clean the fill port carefully before removing the cap to prevent dirt from entering the system. Fill the system with 8 quarts (9 quarts required for initial fill) of M2C41 Hydraulic Oil at temperatures above 10° F. At temperatures below 10° F., use 6 quarts of M-4684-A Hydraulic Oil and 2 quarts of M-4864-D Hydraulic Oil.

   IMPORTANT: ***Do not mix M-4684-A or M-4864-D oils with M2C41 oil.***

5. **Differential:** Change the oil in the differential at the 50-hour inspection and every 600 hours of operation thereafter. In winter, operate the tractor to thin the oil before draining. Fill Series 600 and 601 axle with eight quarts of oil, Series 800, 801 and 1801 with eleven quarts and Series 700, 701, 900 and 901 with eight quarts. Use mild extreme pressure lubricant SAE 80, for both summer and winter operation.

6. **Final Drive Housings—Row Crop Tractors Only:** Change the oil in the final drive housings at the 50-hour inspection and after every 600 hours of operation thereafter. Fill each housing with one and one-half quarts of mild extreme pressure lubricant SAE 80, for both summer and winter operation.

7. **Pedestal:** Drain and refill with E.P. lubricant SAE 80, for both summer and winter operation.

LUBRICATION CHART

EVERY 10 HOURS

13 **CRANKCASE VENTILATING SYSTEM—** Clean and Oil

5 **AIR CLEANER** Clean and Oil

12 **CRANKCASE DIP STICK—**Check Oil Level

16 **HYDRAULIC SYSTEM DIP STICK—** Check Oil Level

LUBRICATE PRESSURE FITTINGS BELOW:

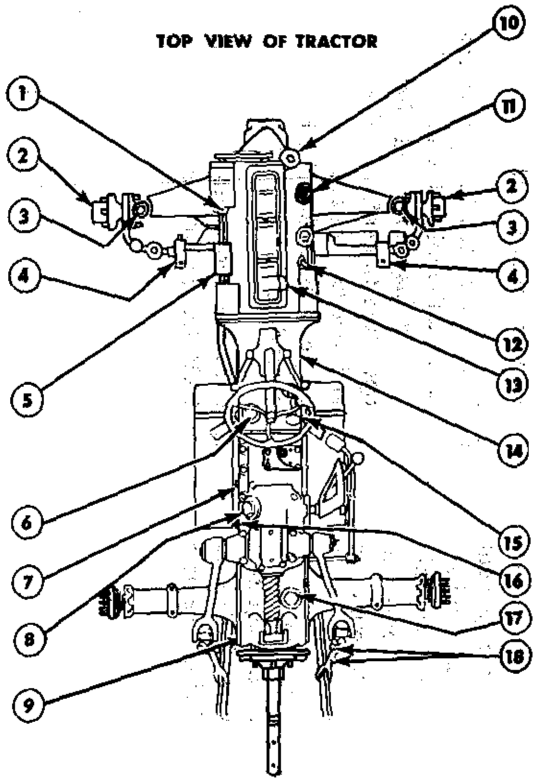
4 **TIE ROD ENDS**

3 **SPINDLE PINS**

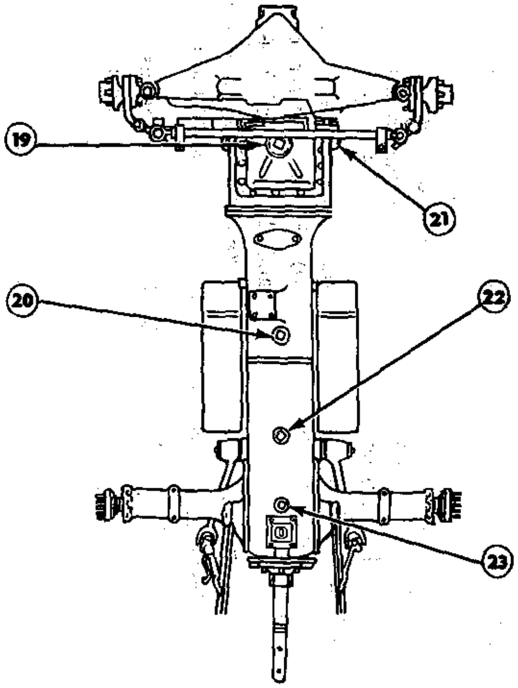
7 **CLUTCH PEDAL**

21 **LEVELING BOX**

TOP VIEW OF TRACTOR



UNDERSIDE VIEW OF TRACTOR



EVERY 600 HOURS

5 **FRONT WHEEL BEARINGS—**Repack with High Grade Short Fiber Grease (Ford Spec. M 4664)

20 and 6 **4-SPEED TRANSMISSION—**Drain and Refill (Use Mild Extreme Pressure Lubricant SAE 80, Both Summer and Winter)

22 and 8 **HYDRAULIC SYSTEM** —Drain and Refill (Below 10° F.—Mix 6 Qts. M 4864 A with 2 Qts. M 4864 D) (Above 10° F.—8 Qts. M 4864 A) or 8 Qts. M 2C41) at any temp.

2 and 17 **REAR AXLE—**Drain and Refill (Use Mild Extreme Pressure Lubricant SAE 80, Both Summer and Winter)

FUEL INJECTORS— Clean and test (diesel only)

EVERY 1200 HOURS

14 **SELECT-O-SPEED TRANSMISSION—**After first 50 hours and at 1200 hours thereafter, drain and refill using M 2C41 Lubricant both summer and winter.

EVERY 100 HOURS

10 **PUMP RESERVOIR—**Check oil level and replenish with M 2C41 Ford Universal Hydraulic Lubricant.

19 and 11 **ENGINE CRANKCASE—**Drain and Refill:
Winter (Below 32° F.) S.A.E. 10—10W
Summer (Above 32° F.) S.A.E. 20 or 30

DISTRIBUTOR—A few drops of engine oil in cup. Do not over lubricate (Gasoline and LP-Gas only)

9 and 17 **REAR AXLE—**Check Oil at Level Plug on Side of Housing and Add Oil if Necessary.

15 and 6 **4-SPEED TRANSMISSION—**Check Oil at Level Plug on Side of Housing and Add Oil if Necessary.

14 **SELECT-O-SPEED TRANSMISSION—** Check Oil at Level and Filler Plug on side of Housing and Add Oil if Necessary (use only M 2C41 Ford Universal Hydraulic Lubricant)

EVERY 200 HOURS

DISTRIBUTOR—Lubricate distributor cam with a film of Ford distributor grease (Gasoline and LP-Gas only)

21 **OIL FILTER—**Replace cartridge every other engine oil change and add one quart of oil to fill new cartridge.

1 **GENERATOR—**Oil rear bearing with light oil. Do not over lubricate.

EVERY 400 HOURS

FUEL FILTER—Replace element (diesel only)

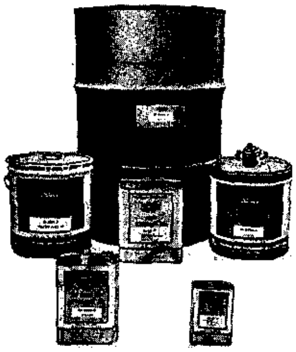
T-2902

Figure 3—Lubrication Chart—Industrial Tractors

GET THE BEST... BUY GENUINE FORD HYDRAULIC OIL

A size and type for all needs

- QUARTS
- GALLONS
- 55 GALLON DRUMS



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- FORD TRACTORS
- FORD EQUIPMENT
- SHERMAN PRODUCTS

OIL USAGE CHART

CHANGE OIL AT THESE RECOMMENDED INTERVALS

TRACTORS

LOCATIONS	MODELS/SERIES	CHANGE OIL EVERY	OIL	CAPACITY
Rear Axle Differential	9N, 2N, 8N	600 hours	M-4864-A (Winter) M-4864-B (Summer)	*5 gallons
	NAA	600 hours	M-4864-A (Winter) M-4864-B (Summer)	9 quarts
	501, 600, 601, 700, 701, 900, 901	600 hours	M-4864-A	8 quarts
	800, 801, 1801, 2030, 4030, 4040	600 hours	M-4864-A	11 quarts
	6000	1200 hours	M-2C53-B	18 quarts
	FMD, FPM (Rear Trans.)	2000 hrs. or 12 mos.	M-4864-A (Winter) M-4864-B (Summer)	†11 gallons
	DEXTA (Rear Trans.)	2000 hrs. or 12 mos.	M-4864-A (Winter) M-4864-B (Summer)	†5 gallons
Transmission	9N, 2N, 8N**	600 hours	M-4864-A (Winter) M-4864-B (Summer)	
	NAA**	600 hours	M-4864-A (Winter) M-4864-B (Summer)	5 quarts
	4-Speed**	600 hours	M-4864-A	6 quarts
	5-Speed**	600 hours	M-4864-A	8½ quarts
	Select-O-Speed	1200 hours	M-2C-41	11½ quarts
	6000	1200 hours	M-2C-41	12 quarts
	FMD, FPM (Front Trans.)	1000 hrs. or 6 mos.	M-4864-A (Winter) M-4864-B (Summer)	5½ gallons
	DEXTA (Front Trans.)	1000 hrs. or 6 mos.	M-4864-A (Winter) M-4864-B (Summer)	14 quarts
Hydraulic System	9N, 2N, 8N	600 hours	M-4864-A (Winter) M-4864-B (Summer)	*
	NAA, 501, 600, 601, 700, 701 800, 801, 900, 901, 1801, 2030, 4030, 4040	600 hours	M-4864-A (M-4864-D may be used in mixture with M-4864-A as required for extremely low temperature operation)	8 quarts
	FMD, FPM, DEXTA	2000 hrs. or 12 mos.	M-4864-A (Winter) M-4864-B (Summer)	†
Hydraulic Package	1801, 4040	500 hrs. or 12 mos.	M-2C-41	5 gallons
	40506	Pump Overhaul	M-2C-41	10 gallons
Hydraulic Reservoir	6000	1200 hours	M-2C-41	3½ gals.
Pedestal	700, 701, 900, 901	600 hours	M-4864-A	2 quarts
	FMD, FPM	1000 hrs. or 6 mos.	M-4864-A	4¼ quarts
Final Drive Housing	501, 700, 701, 900, 901	600 hours	M-4864-A	1½ qts. each housing
Power Steering Unit	600, 601, 700, 701 800, 801, 900, 901, 2030, 4030	Pump Overhaul	M-2C-41	Row crop—2½ pts. 4-wheel—3½ pts.
	1801, 4040, 40506	Pump Overhaul	M-2C-41	4½ pints
Engine	2N, 9N	100 hours		‡7 quarts
	8N, NAA	100 hours	SAE 10W or 20W—Winter	‡6 quarts
	501, 600, 700, 800, 900, 1801 2030, 4030, 4040 & 6000	100 hours	SAE 20 or 30—Summer	‡5 quarts
	FMD, FPM	200 hours	MS or DG for Gasoline Models	‡8½ quarts
	DEXTA	200 hours	DM or DS for Diesel Models	‡8½ quarts

*Common reservoir for differential, transmission & Hydraulic System. †Common reservoir for differential & Hydraulic System. **Sherman Reversing & Step Down Transmissions require an additional pint of oil. ‡Includes 1 quart for replacing filter.

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